H.P.W.

Vol. 11 JULY, 1917 No. 1

356

QUARTERLY

OF THE

National Fire Protection Association

Entered as second-class matter May 1, 1911, at the Post Office at Boston, Mass., under act of July 16th, 1894.

87 MILK STREET, BOSTON, MASS.

EDITED BY THE SECRETARY

National Fire Protection Association.

Executive Office, 87 Milk Street, Boston, Mass.

Franklin H. Wentworth, Secretary

Members.

July, 1917.

American Institute of Architects.
American Institute of Consulting Engineers.
American Institute of Electrical Engineers.
American Institute of Mining Engineers.
American Ceramic Society.
American Gas Institute.
American Electric Railway Association.
American Paper and Pulp Association.
Arkansas Actuarial Bureau.
Associated Factory Mutual Fire Insurance Co's. Inspection Bureau.
Associated Manufacturers of Electrical Supplies.
Associated Metal Lath Manufacturers.
Association of Edison Illuminating Companies.
Association of Fire Underwriters of Baltimore City.
Board of Fire Underwriters of Allegheny County.
Board of Fire Underwriters of the Pacific.
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Florida Fire Prevention Society.
Gypsum Industries Association.
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Illinois State Fire Prevention Association.
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International Association of Fire Engineers.
International Association of Municipal Electricians.
Iowa Rating Bureau.
Iowa State Fire Prevention Association.
Kansas Inspection and Fire Prevention Office.
Kentucky Actuarial Bureau.
Kentucky State Fire Prevention Association.
Kentucky State Insurance Board.
Louisiana Fire Prevention Bureau.
Louisiana State Society for the Reduction of Fire Waste.
Mainland Fire Underwriters' Association of British Columbia.
Massachusetts Mutual Farm Inspection Bureau.
Massachusetts Mutual Fire Insurance Union.
Michigan Inspection Bureau.
Michigan State Fire Prevention Association.
Millers' National Federation.
Mississippi Inspection and Advisory Rating Company.
Mississippi Society for the Prevention of Fires.
Missouri Inspection Bureau.
Mutual Fire Prevention Bureau.
National Association of Building Owners and Managers.
National Association of Credit Men.
National Association of Electrical Inspectors.
National Association of Insurance Agents, The
National Association of Manufacturers of Approved Hollow Metal Window Frames and Sash.
National Association of Manufacturers of United States.
National Association of Master Gravel and Slag Roofers of America.
National Association of the Motion Picture Industry, Inc.
National Automatic Sprinkler Association.
National Board of Fire Underwriters.
National Commercial Gas Association.
National Convention of Insurance Commissioners.
National Electrical Contractors' Association.
National Electric Light Association.
National Implement and Vehicle Association.
National Lumber Manufacturers' Association.
National Paint, Oil and Varnish Association.
National Warm Air Heating and Ventilating Association.
National Wholesale Druggists' Association.
National Wholesale Grocers' Association.
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New England Insurance Exchange.
New Hampshire Board of Underwriters.
New Jersey Schedule Rating Expert's Office.
New York Board of Fire Underwriters.
New York Fire Insurance Exchange.
Newfoundland Board of Fire Underwriters.
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Nova Scotia Board of Fire Underwriters.
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Ohio State Fire Prevention Association.
Oklahoma Inspection Bureau.
Philadelphia Fire Underwriters' Association.
Philadelphia Suburban Underwriters' Association.
Portland Cement Association.
Rocky Mountain Fire Underwriters' Association.
Society Advocating Fire Elimination.
Society for Electrical Development.
Society of Motion Picture Engineers.
Southern Cypress Manufacturers' Association.
South Dakota State Fire Prevention Association.
South-Eastern Underwriters' Association.
St. Louis Fire Prevention Bureau.
Suburban Fire Insurance Exchange.
Tennessee Fire Prevention Association.
Tennessee Inspection Bureau.
Texas State Fire Prevention Association.
Texas State Fire Insurance Commission.
The Union.
Underwriters' Association of the District of Columbia.
Underwriters' Association of the Middle Department.
Underwriters' Association of New York State.
Underwriters' Bureau of Middle and Southern States.
Underwriters' Bureau of New England.
Underwriters' Laboratories.
Vancouver Island Fire Underwriters' Association.
Water Works Manufacturers' Association.
Western Actuarial Bureau (Fire).
Western Canada Fire Underwriters' Association.
Western Factory Insurance Association.
Western Improved Risk Association.
Western Insurance Bureau.
Western Sprinklered Risk Association.
West Virginia Inspection Bureau.
Wisconsin Inspection Bureau.
Wisconsin State Fire Prevention Association.

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Reports on fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

Courtesy of Journal American Institute of Architects.

New Hampshire Avenue, Washington, as it appeared during the May meeting, N. F. P. A.

In the transmission of the heavenly waters every hose fits every hydrant.—*Ralph Waldo Emerson.*

The Quarterly

Vol. 11 **July, 1917** **No. 1**

The Twenty-First Annual Meeting. The published *Proceedings* of the twenty-first annual meeting was mailed to members in June, and the value of the work accomplished during the last fiscal year may be determined by a reading of the record.

It was a hard-working convention, both of the two afternoon sessions holding until nearly six o'clock. The strain was relieved on Wednesday by the visit to the laboratories of the Bureau of Standards and by the delightful automobile ride provided by the hospitable little group of our Washington members. Washington in May is at the period of her greatest beauty, and the capital never appeared to greater advantage than this year when the season had been retarded by the reluctant loosening of Winter's grip. The logic of events made Washington a desirable meeting place this year, although when it was selected war was not declared nor the present session of Congress anticipated. The scramble for accommodations and the crowded condition of the hotels was not, of course, unexpected. Our Washington members exerted themselves to the utmost to relieve the discomforts of the congestion, and most of our people thus found reasonably comfortable quarters.

* * * * *

New City Planning Law. The bill put forward by the New York State Conference of Mayors and other city officials, giving power to cities in New York State to limit the height of buildings and to restrict the use of property, has been passed by the legislature and signed by the governor. All cities in the state, with the exception of Rochester, now have the same power for zoning as has New York City. The new law is as follows:

To regulate and limit the height and bulk of buildings hereafter erected and to regulate and determine the area of yards, courts and other open spaces, and for said purpose to divide the city into districts. Such regulations shall be uniform for each class of buildings throughout any district, but the regulations in one or more districts may differ from those in other districts. Such regulations shall be designed to secure safety from fire and other dangers, and to promote the public health and welfare, including, so far as conditions may permit, provision for adequate light, air and convenience of access, and shall be made with reasonable regard to the character of buildings erected in each district, the value of land and the use to which it may be put, to the end that such regulations may promote

New Hampshire Avenue, Washington, as it appeared during the May meeting, N. F. P. A.

public health, safety and welfare and the most desirable use for which land of each district may be adapted, and may tend to conserve the value of buildings and enhance the value of land throughout the city.

To regulate and to restrict the location of trades and industries and the location of buildings, designed for specific uses, and for such purposes to divide the city into districts and to prescribe for each such district the trades and industries that shall be excluded or subjected to special regulation and the uses for which buildings may not be erected or altered. Such regulation shall be designed to promote the public health, safety and general welfare and shall be made with reasonable consideration, among other things, to the character of the district, its peculiar suitability for particular uses, the conservation of property values and the direction of building development in accordance with a well-considered plan.

* * * * *

Oven Vent Pipes in Contact with Woodwork. It would almost seem as if some builders took a perverted pride in the construction of the unsafe. When they are compelled to keep woodwork away from chimneys, they turn their attention to the possibilities of wood in contact with vent pipes from ovens. One of our members has reported to us a recent fire in a brick apartment house in the city of Cambridge, Mass. The house was a very large one, with many small "kitchenette" suites. The kitchenettes were equipped with gas ranges, the ovens of which were vented by 3-inch pipes carried up inside lath and plaster partitions, and in contact also with studs. Although under ordinary conditions the heat is not great, fire is pretty sure to ensue if anything happens to burn in the oven. In the case reported, the woodwork in contact with the vent pipe inside the partition ignited almost immediately when some pork chops which were being broiled by one of the tenants took fire. Prompt work by the city department confined the loss to the partition on two floors, but a very brief delay would have resulted in a very serious fire. Our correspondent points out that this hazard increases with the age of the structure, both on account of the superior fire-resisting qualities of new buildings and because the continued heat from the vent pipes steadily prepares the woodwork for rapid combustion. It is disheartening to learn that such construction is not only common, but that it is most prevalent in large apartment houses sheltering many tenants.

* * * * *

Permanganate of Potash Fire. We are indebted to Mr. George W. Hoyt, of New York, for the following details of an unusual fire: During the early part of April, 1917, ten packages of permanganate of potash were moved by truck from one warehouse to another in New York City, and there kept on a shipping platform under tarpaulin cover, the shipment having been refused by a railroad company in consequence of the prevailing freight embargo. Two days later, at 9:30 a. m., one of the packages took fire, and was immediately removed from the platform to the street, where it entirely consumed itself. On the following morning another of the packages took fire, and was likewise consumed. Less than two hours later, when the remaining eight packages were being moved by automobile truck, yet a third package was destroyed in the same way. Investigation developed that

permanganate of potash is subject to spontaneous combustion whenever brought into contact with organic matter. This may occur either from foreign matter leaking into the packages or from small crystals of permanganate falling out onto the floor of a warehouse. Agitation such as is caused by trucking will facilitate the process.

* * * * *

Atlanta Conflagration. There can be no question about the grip that the wooden shingle has upon the hearts of the American people—a grip so tight that they are willing for its sake to sacrifice their money, to dislocate their industries, to camp out for a while—in mid-winter, if need be—until ruined cities can be rebuilt; in fact, to run any risk and face any disaster rather than substitute for it some kind of fire-resistive roof covering. The most recent striking example of this wonderful attachment is the Atlanta conflagration of May 21, 1917. Five and a half millions of dollars gone up in smoke, ten thousand persons rendered homeless, most of them losing everything they owned—and all for love of the wooden shingle! This love story—of the American people for the wooden shingle—has already been celebrated in a number of attractive brochures on conflagrations at Paris, Tex., Augusta, Ga., Salem, Mass., and other places, but never more movingly than in the beautifully illustrated report of our member, the National Board of Fire Underwriters, on the Atlanta conflagration. We congratulate the National Board on rising to the occasion.

* * * * *

Fire Protection of Historic Buildings. On another page we print an interesting note by Past-President Robert D. Kohn on the subject of the recent fire in the tower of the New York City Hall, and of the efforts which a number of N. F. P. A. members had made to secure that the building itself and its priceless contents be more adequately protected. The startling fire in the public market at Boston, which threatened the safety of Faneuil Hall, was another reminder to the public of the urgent need for taking up seriously the question of providing sprinklers in the basement of the hall and in the market. Insurance Commissioner James R. Young has been impressing upon the people of North Carolina the peril of their fine State Capitol, and has recommended a number of measures for diminishing the fire hazards of the various State buildings. We earnestly hope that Mr. Kohn's suggestion that members all over the country should interest themselves in the safeguarding of historic buildings from fire will be widely taken up. Such work would be not only useful, but timely.

* * * * *

Not in a spirit of carping criticism, but merely indulging a mild curiosity, we wish to ask Atlanta if she didn't slightly overdo her argument against shingle roofs?—*Rough Notes.*

Meeting of Executive Committee.

The usual meeting of the executives following the annual meeting of the Association was held in New York City on June 29th for consideration of matters referred to the committee by the Association, for revising the roster of the various committees where necessary, and for consideration of reports, finances, communications, etc. The following members were present:

F. J. Stewart, New York, Chairman.
H. W. Forster, Philadelphia.
E. V. French, Boston.
R. H. Newbern, Philadelphia.
C. L. Scofield, Montreal.
Mason R. Strong, New York.
Ira H. Woolson, New York.
Louis Wiederhold, Jr., Philadelphia, President.
D. Everett Waid, New York, Vice-President.
H. O. Lacount, Boston, Vice-President.
Franklin H. Wentworth, Boston, Secretary-Treasurer.

F. E. Cabot, Boston, Chairman of the Electrical Committee, was present by invitation.

In addition to the usual routine, the following items of business were considered and action taken as indicated:

It was VOTED that the *22d Annual Meeting* be held in *Chicago* during the week of May 6, 1918. A *Program Committee* of five was appointed, consisting of the President, Secretary, Chairman of Executive Committee, James E. Latta (Chicago), and Sidney J. Williams (Madison, Wis.)

Messrs. C. L. Scofield and Sidney J. Williams were named to complete the *Nominating Committee.*

Communication from the National Safety Council was discussed, and it was VOTED to advise the *Committee on Fire and Accident Prevention Day* to promote this year as far as practicable the observance of this day on October 9th as usual.

Communication from Mr. Benjamin Richards suggesting the presentation at annual meetings of related reports in special sections with special presiding officers, was favorably endorsed and REFERRED to *Program Committee.*

The *Budget* for the fiscal year as presented by the Treasurer was APPROVED.

It was VOTED to invite the National Board of Fire Underwriters to take over the work of the *Committee on Standard Hose Couplings and Hydrant Fittings* (see report, page 95, Proceedings, 1917), and to abolish the committee if such invitation is accepted.

The report of the special committee on the *Commercial Status of Automatic Sprinkler Installation* was discussed and the committee continued.

The suit of the Economy Fuse and Mfg. Co. against the Electrical Committee was considered, and the Secretary was instructed to prepare a statement of the case for information of the membership.

After discussion of a communication from the National Board of Fire Underwriters suggesting the elimination of construction rules from the National Electrical Code, it was

RESOLVED: That the Executive Committee endorses the principle of confining so far as practicable the work of our committees to requirements for performance and regulations for installation of devices; and instructs all committees to review existing standards in their charge with this principle in view.

It was VOTED that the *Electrical Committee* be requested to give special consideration to the subject of branch wiring of electric lighting circuits in fire-resistive office buildings as presented by our member, the National Association of Building Owners and Managers.

The subject of a special study of *chemical fire hazards,* particularly in connection with the dye and munitions industries (see report of Executive Committee, page 14, Proceedings, 1917), was referred to the *Committee on Manufacturing Risks and Special Hazards.*

The report of the *Committee on Laws and Ordinances* (see page 388, Proceedings, 1917) was discussed, and it was VOTED that the Executive Committee favors the principle of advocating the enactment of laws and ordinances for the establishment of agencies for the administration and co-ordination of fire-prevention measures (see paragraph 11, Annual Resolutions, page 21, Proceedings, 1917), rather than laws and ordinances in which the text of the Association's standards is incorporated.

The resolution of Mr. Powell Evans (see page 24, Proceedings, 1917) to request the Federal Government to investigate, report, publish and distribute a complete study of causes, remedies and compensations of fires in the United States was referred to the Director of the Bureau of Standards (Member Executive Committee, N. F. P. A.), and his counsel requested.

Consideration was given to resolution of Mr. Richard L. Humphrey (page 85, Proceedings, 1917), and it was RESOLVED: That the following regulations shall govern all reports of technical committees:

(a) Except by unanimous consent, no technical committee report shall be presented to the Association in annual meeting which is not received by the Secretary for advance publication before April first of that year. Such reports shall have been submitted to vote of the committee and must have received the approval of the majority of those voting. A statement in the following form shall appear at the close of every committee report:

> This report has been submitted to ballot of the committee, which consists of.....members, of whom.....have voted affirmatively, ...negatively, and.....have refrained from voting.

Dissenting members shall have the right to present minority reports, individually or jointly, at the annual meeting at which the majority report is presented.

(b) Proposed new standards or proposed amendments to existing standards must originate in the particular committee within whose province such standards properly belong, and be presented to the Association in annual meeting for consideration and action.

The following proposed additions to the Articles of Association were referred to the committee on that subject for consideration:

(1) Adoption or amendment of standards shall require a two-thirds vote of the vote entitled to be cast by members and associate members present and voting. All proposed new standards, if accepted, shall be tentatively adopted at the meeting at which they are first presented, and shall be printed in the *Proceedings* and considered for final adoption at the succeeding annual meeting, except that for exceptional reasons this rule may be waived by a nine-tenths vote of the members and associate members present and voting.

(2) The Executive Committee shall have authority to approve standards for promulgation during the interim between annual meetings, provided that such subjects shall first be laid before any special committees appointed to deal with such matters. It is further understood that any such action by the Executive Committee shall be reported to the next annual meeting of the Association.

Resolution of Mr. Joseph O. Hammitt (page 22, Proceedings, 1917) relating to control of chemicals was REFERRED to *Committee on Explosives and Combustibles,* with request that the matter be considered and report rendered to the Association.

Suggestion of Mr. A. R. Small (page 32, Proceedings, 1917) regarding suspension of dues of members enlisting in the army or navy was favorably considered, and the Secretary was requested to insert notice of the same in the *News Letter.*

The Committee on *Standpipes and Hose Systems* reported further consideration of items referred back by the Association (see report, page 202, Proceedings, 1917). The amended report was ADOPTED, subject to approval of the officers, and publication recommended.

It was VOTED that the report of the *Committee on Openings in Walls and Partitions* (page 333, Proceedings, 1917) be submitted to a mail vote of the Executive Committee after further correspondence with the committee submitting the report.

The following revisions of regulations by the *Committee on Explosives and Combustibles* were approved:

(a) Containers for Hazardous Liquids.
(b) Fuel Oil Installations.
(c) Internal Combustion Engines.
(d) Acetylene Lighting and Welding, and Storage of Calcium Carbide.

The National Association of Manufacturers of Appproved Hollow Metal Window Frames and Sash was elected a member.

The following committees were suspended:

Forest, Brush and Grass Fires.
Standard Hose Couplings (see special action).

All other committees were continued, and changes in the membership thereof, if any, will be shown in the forthcoming Year Book.

Not In It.

A fire loss of $214,000,000 would in former days have called forth expressions of shocked surprise. In the presence of war expenditures ranging in different nations up to $30,000,000 a day, the "red destroyer" is a pale-pink piker.—*New York World.*

Artistic Effects in Modern Terra Cotta.

This ornamental panel from a Cincinnati church is one of a series, modeled for its decoration and produced in grey granite vitreous enamel terra cotta by the Northwestern Terra Cotta Company.

Safety for Firemen.

Pennsylvania Department of Labor and Industry
(Member N. F. P. A.)

There has been a great deal said about safety for employees in case of fire, and much emphasis is being placed on protective methods, such as an orderly arrangement of all working materials, constant practice of fire drills and the use of first aid fire fighting equipment in industrial plants. The safety of employees is the purpose emphasized. There is another group of men also highly deserving of consideration in these protective schemes.

In case of a fire in an industry that becomes of large enough proportions to call in the company's firemen or the town or city firemen, some thought should be given in advance to the conditions which would make the work of these men most safe and efficient. Many of the conditions which would insure safety for firemen are also the same under which all persons in a plant would be best protected; but in repeating the details, the fireman's safety is empha-

sized, since to this group of men belongs the duty of assuming the most dangerous tasks connected with burning buildings. The employees' duty is to leave these buildings as rapidly as possible; the fireman's duty is to enter and attack the fire.

In entering or leaving buildings with greatest speed and safety, the first requirement is free passageways. In plants where the orderly arrangement of all machinery and materials is the constant rule, nothing more in this matter is needed as a fire precaution. Orderly arrangement would include aisles free from any accumulation of materials that would cause a person walking rapidly to stumble or fall. Another necessity is that the flooring of all passageways shall be level, free from sudden depressions or any unexpected irregularities. It is to be remembered that the smoke of a fire would be apt to shut off light in many such places, and flooring irregularities would become dangerous. All openings should be carefully guarded.

The need of stopping all machinery in case of fire is generally recognized as of great importance and regularly attended to; but for the safety of firemen entering machine shops, it is of value to emphasize the great danger to them of machinery left in motion.

Another condition that would greatly endanger the lives of firemen is the presence of explosives in burning buildings. It has been found in many instances that persons constantly handling explosive liquids or other material become exceedingly careless concerning them. The remedy would be to keep all such material in storehouses built purposely for it at a distance from the main shops. That would insure the least harm in case of fire and explosion.

A frequent cause of accidents to firemen is falling glass; but at the present time, wired glass is coming constantly into greater use, and is giving effective service. It not only prevents accidents from falling glass, but is a greater barrier to smoke and flames. Wired glass in metal frames used for all windows is one of the best aids in preventing the spreading of flames and insuring the safety of the lives of those whose duty it is to fight fires.

In view of the fact that in case of fire the firemen are the ones by whom the greatest risks must be taken, every scheme of fire prevention and protection should include safety not only to the employees of any industry, but also to the firemen.

The Burning of Ingram's House.

(From the *New York Times.*)

Monday was dank, dark, watery, chilly, windy, puddly. A day for potatoes to tear their eyes out. How could anything grow, except worse, on such a totally depraved and cheerless day? A day for fires, but how many of us could beg, borrow or steal either wood or coal? Yet warming there must be, artificial but not alcoholic, in such hours of gloom. The cheapest, warmest fuel for a cold day is "The Burning of Ingram's House," the strong and fine poem in which the Rev. J. K. Harris of Chilhowee relates a recent excitement of that Missouri town:

He [Ingram] was sitting alone while reading the news,
When suddenly startled by a brick from the flue.
He ran upstairs to see what was there,
But fire and smoke filled the air.

The preacher was preaching with all his might,
After announcing his theme for discussion at night.
Some one shouted, "There is fire! There is fire!"
And the preacher was left alone in the choir.

The wind from the north and the rain pouring down
Were the only reasons it didn't burn the town.
Men fought with salt and fought with water,
While the flames on the south got hotter and hotter.

The last two lines cannot escape immortality. While all tender hearts must regret "the fault of an imperfect flue that had stood so long the fire broke through," Ingram's loss is the world's gain; and fireless houses find in this song of fire, preserved by *The Chilhowee Blade*, a talisman and antidote against the intempestive malice of Summer playing Winter.

Burning Tower of City Hall, New York.

Fire in New York City Hall.

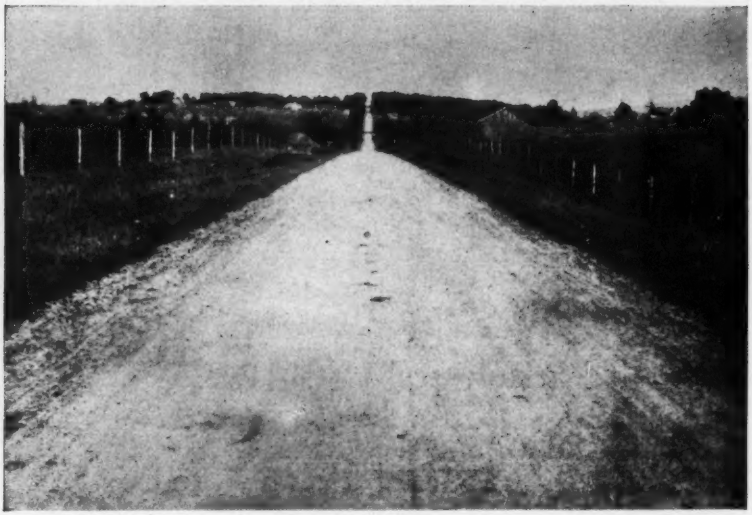
By Robert D. Kohn
(Past President, N. F. P. A.)

Some of the members of the National Fire Protection Association in New York have been urging the city officials for a number of years to protect the City Hall building with sprinkler equipment. The New York City Hall is a beautiful building started about 1810, and is not only architecturally admirable as a record of the style of that time, but contains a good many irreplaceable historical treasures. There were a number of small fires in the building—the first about two years ago and another about three months ago—which aroused public sentiment to the extent that the Fire Commissioner and the Borough President of Manhattan were both urged to consider sprinkler installation in the basement and in the attic space above the ceiling of the second story and up in the tower. They were told that Old South Church in Boston was sprinklered up into the tower, and the same could certainly be done with no great risk in the New York building.

As we all know, a serious fire broke out in the roof and the cupola on May 10th, and did about $25,000 damage. As a result of the agitation previously started by members of the Association, plans were actually under way on that day to provide for at least a layout of sprinkler equipment for the building. It is stated by the city authorities that the fire started between the roof boards and the ceiling, where sprinklers would not have helped. Be this as it may, it is a great satisfaction to know that the commissioners of the Sinking Fund have now decided that all concealed roof spaces are to be properly fire-stopped, and that it is desirable to install sprinklers, and a request has been made to the Board of Estimate for sufficient appropriation for that purpose.

It would be well if members in different parts of the country would urge the protection of historical buildings in the same fashion. The Institute of Architects is having its historic building in Washington, The Octagon, protected at the present time by the installation of sprinklers in the basement, under the staircase and up in the attic and in other concealed spaces. This building, like many historical examples of Colonial architecture, is not of fire-resistive construction, and the architects felt it was their duty to preserve it against any possible harm.

These Are Roads—



The value of the service that under modern conditions can be rendered by its neighbors, to a city in the grip of a conflagration, is increasingly dependent upon the facilities that exist for getting automobile apparatus rapidly to the scene of action. The

But What Are These?

run of 32 miles in 45 minutes made by the fire fighters of Waynesboro, Ga., in their rush to the help of burning Augusta last year was not a bit too fast, as the Waynesboro men themselves would be the first to admit. But fancy attempting even a quarter that speed on such tracks — they can hardly be called roads — as these shown on this page! At a time of conflagration, a city cut off from its neighbors by "roads" like these might almost as well have no neighbors.

Making Burnable Institutional Buildings Safe.

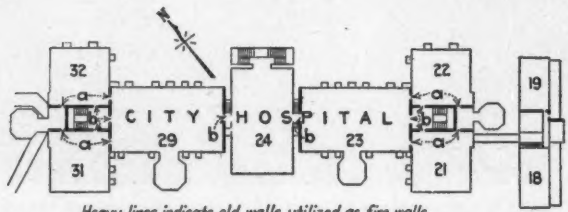
Courtesy of Engineering News.

Methods employed by the City of New York in making safe many of the originally nonfireproof institutional buildings under the Department of Charities. Main reliance is on vertical firewalls, which in case of fire permit ready horizontal transfer of inmates to an adjacent safe section under same roof. Additional protection in the way of signals, pipe lines, chemical engines, fireproof doors and windows, etc.

With the award of the contract for the remaining portion of the work comprising the improvements in the three groups of buildings on Blackwells Island, the Kings County Hospital group in Brooklyn and the isolated buildings scattered throughout the greater city, all the fire-protection work contemplated in the Department of Public Charities is now contracted for. Similar work in the buildings on Randalls Island and in the New York City Farm Colony on Staten Island was completed last year.

Inasmuch as safety to life problems are comparatively new and as these alterations are the most extensive of any such work that has thus far been undertaken, a brief history and description of them will be of interest.

Immediately after the Asch Building disaster in March, 1911, the late M. J. Drummond, then Commissioner of Charities, became solicitous for the safety of the helpless wards of the city filling the numerous nonfireproof institution buildings in his department. Upon his request a survey was promptly made by a committee that inspected 32 of the principal buildings having a large occupancy and recommended the installation of additional water mains, pumps, standpipes, hose, fire extinguishers, etc., the construction of numerous outside fireproof balconies with stairways, outside fire escapes both of the usual patterns and of the helical-chute type. The total estimated cost of the work in the 32 buildings was $149,000, and this amount was appropriated for the purpose by the city.



Heavy lines indicate old walls utilized as fire walls
Letters a and b indicate type of fire doors

Fig. 1. Plan of City Hospital Building, showing old walls utilized as fire walls.

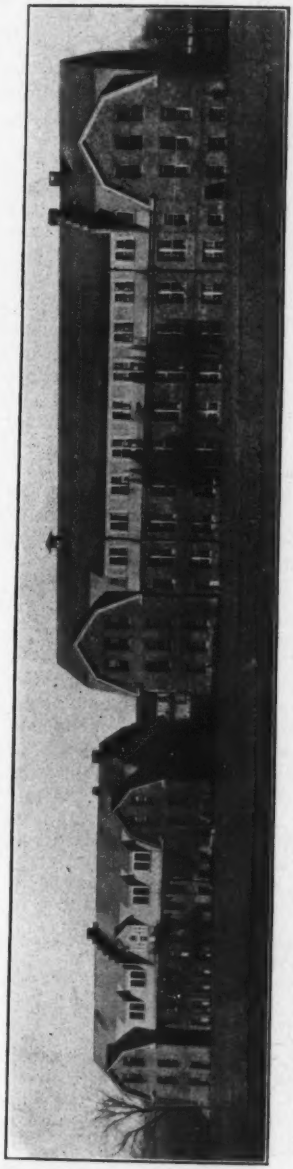


Fig. 2. Typical buildings to which firewalls have been added at New York City Farm Colony, Staten Island. In building on left a new firewall shown projecting above the roof, has been built. In building on right an existing wall has been made into a firewall.

Before advertising for bids, however, the city engaged H. F. J. Porter and A. L. A. Himmelwright to review the findings of the committee and make a further detailed study of all the buildings under the jurisdiction of the department, numbering 206. From their report most of the following data are gleaned.

General Protection Methods Followed.

The character of the buildings ranged from the recently completed fireproof buildings with incombustible floor finish, trim, etc., to temporary frame structures; but the large majority were of the nonfireproof type three to five stories high, with masonry walls, wood interiors and wood roofs covered with tin, slate, or tar and felt roofing.

The varied occupancy of the buildings—from infants to adults of both sexes, including the feeble-minded, blind, aged, and helpless hospital patients — still further complicated the fire-hazard problems. It was impossible, therefore, to follow any set rule in the treatment of the buildings; each had to be considered separately, solving the problems presented in each and taking advantage of any favorable conditions that existed. In this manner the most practical and economical treatment that would provide reasonable safety to life and protection to property was determined for each building.

In nearly all the larger buildings masonry dividing walls were found, which originally were exterior walls before wings and additions were built. Such of these walls as occupied strategic positions and could readily be developed into and be utilized as

firewalls were recommended to be so converted. In this manner the danger zone from fire to both life and property in these buildings was reduced by vertical subdivision. This principle of the division of the fire hazard by utilizing existing walls or firewalls was found to be quite generally applicable and was recommended and later adopted on the grounds that it secured largely increased safety at less cost than any other treatment that had been previously suggested.

The report also embraced a complete design for a fire-signal system for all the buildings in each group. This system was specially adapted to the character of the occupants, and signaled only those who were in the danger zone and automatically called the fire-fighting forces to the fire and notified the central office.

The fire alarms that had been in use were a code of whistles blown from the boiler plant in each group. These were pronounced unsuitable and inadequate because of possible failure and always delay on account of the necessity of telephoning from the building in which the fire occurred to the boiler plant, and the unnecessary alarm of those not in the danger zone, the excitement often injuring those who were very ill and weak, and retarding their recovery.

For the groups of buildings on Randalls Island and the Farm Colony, Staten Island, which are isolated from the city fire department protection, chemical fire engines and special local fire-fighting brigades were recommended. The minor fire hazards, now usually designated as housekeeping conditions, were all pointed out, and the most practical manner of eliminating them was suggested in the case of each and every building.

This report was approved and adopted by the city, and Messrs. Porter and Himmelwright were engaged to prepare plans and specifications and to supervise the work of construction. The most urgent of these improvements were contracted for and completed last year, and the remainder are now in progress. A general idea of the character, location and number of the buildings embraced in this work will be given by the accompanying table. The total contract cost of the protection to 206 buildings was $117,000.

BUILDINGS PROTECTED AGAINST FIRE FOR THE DEPARTMENT OF PUBLIC CHARITIES, NEW YORK CITY

Group	Location	Character of Inmates*	Number of Buildings†	
			Institutional	Service
City Hospital.....	Blackwells Island....	General hospital and surgical	15	5
City Home	Blackwells Island....	Aged, blind, neurological	23	9
Metropolitan Hospital	Blackwells Island....	General hospital, surgical, tubercular	21	6
Kings County Hospital	Brooklyn	General hospital, surgical, tubercular aged, blind and cripples	28	7
Randalls Island	Randalls Island.....	Feeble-minded children	31	7

Group	Location	Character of Inmates*	Number of Buildings† Institutional	Service
Farm Colony	Staten Island.....	Poor, aged, but able-bodied	14	6
Sea View Sanitarium.	Staten Island.....	Tubercular	13	2
Cumberland St.....	Brooklyn	General hospital, surgical, infants	2	1
Coney Island.....	Coney Island.....	General hospital, surgical	4	2
Isolated buildings....	Greater New York...	Administration buildings	8	2
			159	47

Grand total = 206

* The average population in all the groups is about 17,000. †Service buildings include boiler houses, laundries, workshops, storehouses, kitchens, bakeries, garages, stables, etc.

How Protection in City Hospital Is Accomplished.

A very good idea of the manner in which all the buildings are being made safe can be obtained by a description of the treatment of a few that are typical.

The City Hospital, which is the main building of the City Hospital group, will be an excellent illustration of the treatment of the large hospital buildings. A small-scale floor plan is reproduced herewith (Fig. 1). The building is four stories and basement in height. It has stone walls, wood interior and a wood roof covered with slate. Its capacity is 1000 beds, and its normal occupancy when filled with patients is from 1400 to 1500 persons, there being 400 to 500 nurses, attendants, surgeons, visitors, help, etc. A large number of the patients are bedridden and helpless. The standpipes are connected with the house water-supply system. One fire-engine company is located near the middle of the island and requires 5 minutes to reach the building. Other fire-department apparatus and men from Manhattan cannot reach the building in less than 40 minutes. A fire in any part of the building would endanger the whole structure and annex, and would jeopardize the lives of all the occupants. The fire-drill scheme proposed, in case of fire, to call all the help from the service buildings by means of a code whistle at the boiler house and attempt to extinguish the fire and empty the building of all the occupants. The possibilities of such a procedure on a stormy winter night were very discomforting to the Commissioner of Charities, but it was the best that could be done under the existing conditions.

The accompanying floor plan indicates that the building consisted of an original building 24, with two wings 23 and 29 added later, and after that two additions at each end 21, 22, and 31, 32, with an annex 18, 19 connected with the main building by a bridge at the second-floor level. The heavy dividing lines indicate existing masonry walls occupying strategic positions that are to be converted into fire walls, thus dividing the main building into seven vertical sections or fire units, as they are designated, and the annex into two

additional units. Between units 21 and 22, and 31 and 32 are fireproof stair halls and stairways inclosed by 17-inch brick walls.

All the walls to be converted into fire walls are to be extended through the attics and roof and to an average height of 3½ feet above the roof and are to be coped. The woodwork on opposite sides of these walls is thoroughly isolated. All openings in these walls, except specified doors to be used as horizontal exits and designated as A and B doors, are to be bricked in solidly the full thickness of the walls. Where there is any probability of fire spreading around the ends of these walls, one or two vertical lines of windows are fireproofed by substituting metal trim and sash and wired glass for the present windows. All wood cornices and projecting wood roofs within 5 feet on each side of the line of the wall are to be replaced by hollow metalwork, fire-stopped along the line of the fire walls and duplicating in design and color the woodwork replaced.

All the present woodwork in the door openings in the fire walls is to be removed, including all trim, flooring, etc. The head and jambs are to be finished in hard plaster, and a concrete with a cement-finished sill is to be built up from the wall by corbeling out the wall 4 inches on each side of the opening, so this sill will extend under the firedoors in the closed position in all cases. Standard sliding Class A firedoors are specified to protect all openings in the cellars and attics, and hinged Class B standard fire doors, finished in harmony with the trim of the wards into which they open, protect the openings in the other stories.

This treatment converts the walls shown into real fire walls, making them practically as effective against the spread of a fire from one unit to another as if separated by a party wall. In other words, they divide the main building into seven separate and different buildings in so far as the fire hazard is concerned. Consequently, only about one-seventh of the occupants and one-seventh of the building can be endangered by fire at any time, no matter where it may occur. The fire hazard to both life and property in this building is therefore by this simple treatment reduced to only one-seventh of what it was formerly. Neither is it necessary by this plan to move the patients out of doors, as was formerly the case.

The horizontal-exit plan has the further advantage that the helpless and bedridden patients can be moved in their beds without discomfort or injury, that those physically able to walk or crawl may themselves reach safety without assistance or fear of injury to themselves by falling down stairways, and that when the horizontal exits are being used by the occupants the stairways, fire escapes, elevators, etc., are free and unobstructed, thus enabling the fire-fighting forces to reach the fire in the minimum time and fight it with the maximum efficiency.

In all cases at least two exits of sufficient capacity and as remote from each other as practicable are provided on each floor in each fire unit. Horizontal exits between wards through which beds are to be moved are 5 feet 6 inches wide and 7 feet high in the clear. Helpless patients are to be placed on beds near the horizontal exits, and these

beds are fitted with special nonabrading, ball-bearing, nonswiveling casters with 3-inch diameter wheels for the head legs only. This arrangement preserves the stability of the beds the same as usual and permits the easy removal of the patient in his bed by a nurse or attendant lifting the foot of the bed and wheeling it away.

Additional Protection in City Hospital.

Fig. 3. Horizontal exit through fire wall in Farm Colony Building.

The fire-signal system in this building is designed so as to adapt it to the improved conditions. The signals operate only in the one fire unit in which the fire occurs and in no other. Every signal is nevertheless transmitted automatically to the central office and the shops, dormitories and other service buildings, apprising them of the fire and its location and thus summoning assistance without delay. A city fire department call box is located in the central office, through which the day or night operator can instantly relay the call to the fire department. In the hospital wards the signals consist of red lights and tappers that do not alarm the patients, while in the service and administrative units the signals are single-stroke gongs of suitable sizes to fulfill the requirements. In the annex units 18 and 19 two new stairways, one on each side of the fire wall, had to be introduced at each end of the building.

Numerous details required attention so as to perfect the safety scheme. In many cases water, steam and sewer pipes passed through openings in basements, cellars and attics that required fire door protection. When the pipes were at the top of the openings, permanent brick transoms 8 inches thick and supported on channels were built in the upper part of the openings and the rest protected by fire doors. Similarly, sills were raised when pipes occurred at the bottom of the openings.

Occasionally, wood floor and roof beams were continuous through or over walls that were to be utilized as fire walls. Such timbers are to be cut at the wall and the ends separated by not less than 6 inches of cement mortar rammed so as to isolate thoroughly the woodwork on each side. When sufficient bearing is not remaining, steel stirrups shall be supplied.

All wood beams supported by fire walls are required to be beveled so as to be self-releasing in case of fire on either side of the wall. Dormer windows within 10 feet of a fire wall and within 2 feet of the face of the exterior walls shall be protected by sheet-metal covering and fireproof window frames, sash and wired glass.

Typical Protection in Other Buildings.

Another typical example of the firewall treatment is in the Infants Hospital Building on Randalls Island. This is a brick structure three stories and basement high, with wood interior and wood roof covered with slate in the mansard portions and with tar and felt in the flat portions. It is used as an administration building and a dormitory for feeble-minded boys.

In this building certain existing walls were utilized as firewalls. These were found to be more desirable for the purpose than walls

Fig. 4. Fire doors and horizontal exit, Infants' Hospital Building, Randall's Island.

coinciding with the projections above the roof. An interesting problem was presented by a long wooden piazza with wood roof extending along the entire north side of the building east of the west wing. The piazza extended around the ends of all firewalls. The best solution was found to lie in fireproofing 20-foot sections of the piazza

adjacent to the ends of the fire walls. In the case of the dormitories for aged males and females in the City Home group, Blackwells Island, where similar three-story wooden balconies skirted the fire walls, the latter were extended through the balconies.

In the Farm Colony, Staten Island, four large new dormitories of nonfireproof construction, with stone walls, were divided into approximately two equal parts by new fire walls; but only in one other building of the 64 treated by the firewall principle (five in all) were new firewalls required. The appearance of the old and new firewalls above the roof may be noted in Fig. 2.

The views of interiors in Figs. 3 and 4 are typical of the appearance of the fire doors cut through the fire walls for horizontal exits.

The effect of the firewall treatment in these buildings renders them substantially as safe for their occupants as the average fireproof building with wood floor finish and trim and unprotected window openings, which is typical of 95% of our modern buildings.

The usefulness and serviceability of these old-type, nonfireproof, institutional buildings is, therefore, indefinitely prolonged by this treatment, and a large economic result is thereby attained which could not be realized short of entire reconstruction at enormous expense.

Comparative Statistics of Fire Loss.

Like its predecessors, the Annual Report for the year 1916 of the Committee on Statistics and Origin of Fires of the National Board of Fire Underwriters is very interesting reading. After expressing its conviction that nothing else than an aroused public conscience will ever check our huge annual fire waste, the Committee comments briefly upon one or two of the outstanding causes of the increase from $172,033,200 (or $1.71 per capita) in 1915 to $214,530,995 (or $2.10 per capita) in 1916. The first of these causes is the wooden shingle roof, which was mainly responsible for the disastrous conflagrations at Augusta, Ga., Paris, Texas, and Nashville Tenn., which on the 21st and 22nd of March, 1916, destroyed property of the estimated value of $13,500,000. Reference is also made to the Black Tom Island Explosion of July 30th, 1916, which involved a loss of $11,000,000, and more stringent regulations relating to the storage, transportation and handling of explosives are advocated.

The statistics which follow are reprinted from the Committee's Report. Owing to the present conditions in Europe, comparative statistics of the fire losses in different countries are omitted from the report this year.

Cities in Which Loss Exceeded $5.00 Per Capita.

1916.

Jersey City, N. J.	$27.71	*Houston, Texas	$6.90
Asheville, N. C.	14.93	†East St. Louis, Ill.	6.28
†Ottumwa, Ia.	12.68	*Little Rock, Ark.	6.27
Green Bay, Wis.	12.08	Chicopee, Mass.	5.97
†Dubuque, Ia.	9.12	Cedar Rapids, Ia.	5.94
Fall River, Mass.	9.09	*Portland, Me.	5.87
Shamokin, Pa.	9.07	Amsterdam, N. Y.	5.81
*Peoria, Ill.	8.51	Duluth, Minn.	5.75
Norfolk, Va.	8.25	New Castle, Pa.	5.09
†Columbia, S. C.	8.10	Spartanburg, S. C.	5.07
Sandusky, Ohio	7.60	*Cohoes, N. Y.	5.05
Austin, Texas	7.43		

1915.

Newport News, Va.	$28.00	Danville, Ill.	$6.86
Clinton, Ia.	12.46	Joliet, Ill.	6.83
Augusta, Ga.	11.87	*Galveston, Tex.	6.52
Raleigh, N. C.	10.37	Springfield, Ill.	6.47
Key West, Fla.	9.41	‡Fresno, Cal.	6.24
Lockport, N. Y.	9.31	†Port Huron, Mich.	6.06
Muncie, Ind.	9.16	†Salem, Mass.	5.85
Davenport, Ia.	8.80	Muskegon, Mich.	5.57
*Trenton, N. J.	8.11	Williamsport, Pa.	5.48
Erie, Pa.	7.78	†Dubuque, Ia.	5.35
‡Shreveport, La.	7.64	Burlington, Ia.	5.14
Wilkinsburg, Pa.	7.50	Oswego, N. Y.	5.14
*Montgomery, Ala.	6.94		

1914.

*Galveston, Tex.	$33.06	Portland, Ore.	$6.78
Pottsville, Pa.	20.38	Kearny, N. J.	6.48
†Port Huron, Mich.	16.13	Kenosha, Wis.	6.47
*Trenton, N. J.	15.32	*Portland, Me.	6.26
Decatur, Ill.	15.28	*Binghamton, N. Y.	6.24
Manchester, N. H.	14.07	Waco, Tex.	6.12
Superior, Wis.	13.86	†East St. Louis, Ill.	6.10
Charleston, W. Va.	13.83	‡Shreveport, La.	6.05
*Waterloo, Ia.	12.60	Pasadena, Cal.	5.97
*Gloversville, N. Y.	12.29	*Pittsfield, Mass.	5.93
‡Fresno, Cal.	12.03	Portsmouth, Ohio	5.93
*Montgomery, Ala.	10.51	Memphis, Tenn.	5.67
*Sioux City, Ia.	10.43	Albany, N. Y.	5.46
Vicksburg, Miss.	9.38	Montclair, N. J.	5.12
Leavenworth, Kan.	9.12	Fort Worth, Tex.	5.05
†Birmingham, Ala.	7.37	Mobile, Ala.	5.04
Charlotte, N. C.	7.28		

1913.

*Columbus, Ga.	$40.91	Elmira, N. Y.	$8.49
†Ottumwa, Ia.	16.39	Jackson, Miss.	7.58
*Cohoes, N. Y.	15.43	Parkersburg, W. Va.	7.50

1913.

Savannah, Ga.	13.91	*Norwood, Ohio	7.30
†Port Huron, Mich.	13.72	*Walla Walla, Wash.	6.99
Quincy, Ill.	13.26	†Columbia, S. C.	6.50
*Salem, Mass.	12.08	*Binghamton, N. Y.	6.45
*Gloversville, N. Y.	11.81	Springfield, Mo.	6.42
Dayton, Ohio	11.60	*Little Rock, Ark.	6.31
†Dubuque, Ia.	10.43	*Peoria, Ill.	5.83
†East St. Louis, Ill.	10.12	Boston, Mass.	5.79
Lynchburg, Va.	9.94	‡Fresno, Cal.	5.52
Everett, Wash.	9.69	Burlington, Vt.	5.39
San Jose, Cal.	9.39	Stockton, Cal.	5.33
‡Shreveport, La.	9.17	*Flint, Mich.	5.01
New Rochelle, N. Y.	8.69		

1912.

*Houston, Tex.	$51.14	Fort Smith, Ark.	$6.63
North Adams, Mass.	15.41	Dallas, Tex.	6.32
*Sioux City, Ia.	12.69	‡Shreveport, La.	6.05
*Petersburg, Va.	11.71	Belleville, Ill.	5.87
Moline, Ill.	11.60	Easton, Pa.	5.66
†Ottumwa, Iowa	10.65	South Bethlehem, Pa.	5.66
*Flint, Mich.	10.38	*Birmingham, Ala.	5.57
Butte, Mont.	9.84	*Meridian, Miss.	5.54
†Columbia, S. C.	9.69	*Norwood, Ohio	5.32
*Pittsfield, Mass.	9.13	Rockford, Ill.	5.20
*Columbus, Ga.	8.67	Taunton, Mass.	5.06
‡Fresno, Cal.	7.75	*Tacoma, Wash.	5.04
Perth Amboy, N. J.	7.15	Newport, R. I.	5.01
*Walla Walla, Wash.	6.74	Haverhill, Mass.	5.01
*Waterloo, Iowa	6.71		

*These cities in this class in two of the five years.
†In this class three of the five years.
‡In this class four of the five years.

*ANNUAL FIRE LOSSES IN THE UNITED STATES FOR FORTY-TWO YEARS — 1875-1916 INCLUSIVE.

YEAR	AGGREGATE PROPERTY LOSS	YEAR	AGGREGATE PROPERTY LOSS	YEAR	AGGREGATE PROPERTY LOSS
1875	$78,102,285	1889	$123,046,833	1903	$145,302,155
1876	64,630,600	1890	108,993,792	1904	229,198,050
1877	68,265,800	1891	143,764,967	1905	165,221,650
1878	64,315,900	1892	151,516,098	1906	518,611,800
1879	77,703,700	1893	167,544,370	1907	215,084,709
1880	74,643,400	1894	140,006,484	1908	217,885,850
1881	81,280,900	1895	142,110,233	1909	188,705,150
1882	84,505,024	1896	118,737,420	1910	214,003,300
1883	100,149,228	1897	116,354,575	1911	217,004,575
1884	110,008,611	1898	130,593,905	1912	206,438,900
1885	102,818,796	1899	153,597,830	1913	203,763,550
1886	104,924,750	1900	160,929,805	1914	221,439,350
1887	120,283,055	1901	165,817,810	1915	172,033,200
1888	110,885,665	1902	161,078,040	1916	214,530,995

*These figures are obtained from the Records of the Journal of Commerce, deducting the Canadian losses.

Conflagrations Involving Losses of $500,000 and Over, Occurring in 1916.

(From Records of Journal of Commerce.)

1916.				
Jan.	7	Cincinnati, Ohio	Railroad depot and express building	$800,000
	7	Youngstown, Ohio	Business section	800,000
	11	Ottumwa, Ia.	Dept. store and others	500,000
	13	Holly Springs, Miss.	Cotton compress	500,000
Feb.	5	Scranton, Pa.	Business bldg. and theatre	500,000
	16	Fall River, Mass.	Dept. store and others	2,000,000
	16	Brooklyn, N. Y.	Pier and steamers	2,000,000
	19	Kingsport, Tenn.	Chemical plant	500,000
	25	Pittsburgh, Pa.	Storage warehouse	500,000
Mar.	6	Peoria, Ill.	Grain elevator	1,000,000
	10	Brunswick, Ga.	Naval stores, plant and yard	750,000
	12	Buffalo, N. Y.	Fertilizer plant	550,000
	15	St. Louis, Mo.	Glass plant	500,000
	21	Copper Hill, Tenn.	Munitions plant	500,000
	21	Paris, Tex.	General conflagration	7,000,000
	22	Nashville, Tenn.	Residence section	1,500,000
	22	Augusta, Ga.	Several business blocks	5,000,000
	22	Tulsa, Okla.	Oil field property	1,500,000
	26	New Haven, Conn.	Railway shops and yard	700,000
	26	Houston, Tex.	Cotton and railroad shops	500,000
Apr.	7	Bayonne, N. J.	Oil storage plant and pier	500,000
	25	Decatur, Ala.	Cotton compress	1,000,000
May	8	Duluth, Minn.	Lumber yards and contents	500,000
	8	Chicago, Ill.	Chair manufacturing plant	500,000
	9	Asheville, N. C.	Standing timber	500,000
	12	Sandusky, Ohio	Several business stores and livery stable	500,000
June	4	San Francisco, Cal.	Pier and freight	750,000
	10	Stephens Pottery, Ga.	Sewer pipe and clay works	500,000
	13	Baltimore, Md.	Grain elevator	1,250,000
	14	Cleveland, Okla.	Five oil tanks	500,000
	30	Seattle, Wash.	Steamship pier	500,000
July	27	New York, N. Y.	Storage warehouse	1,000,000
	30	Jersey City, N. J.	Railroad terminal, warehouses, piers, steamers and barges	11,000,000
Aug.	29	Vallejo, Cal.	Flour warehouse	500,000
	29	Merrill, Wis.	Tannery	500,000
Sept.	24	Phoenix, N. Y.	Business section	684,000
Oct.	15	Milwaukee, Wis.	Malt plant and elevator	500,000
	25	Oroville, Cal.	Lumber plant	500,000
	29	Butler, Pa.	Steel car company's power plant	500,000
Nov.	6	St. Paul, Minn.	Lumber storage yard	512,500
	16	Ithaca, N. Y.	Salt works	500,000
	19	Chicago, Ill.	Freight storage yard and warehouse	500,000
Dec.	16	Los Angeles, Cal.	Iron works	500,000
	19	Fremont, Neb.	Grain elevator	500,000
	31	North Augusta, S. C.	Hotel	600,000
				$52,896,500
		Conflagrations prior to 1916 (since 1866)		1,248,207,135
				$1,301,103,635

NOTE.—Some of these losses are higher than the total losses reported by the Chief of the Fire Department for the year.

State Fire Marshals.

State	No. of Employes		No. of Towns or Cities Visited	No. of Inspections Made			No. of Orders issued for correction of defects	No. of Bldgs. Condemned or Razed	No. of Arrests for Incendiarism	No. of Convictions Secured	No. of Deaths as the result of Fire	No. of Persons Injured	No. of Circulars or Pamphlets Issued	No. of Fire Prevention Addresses made
	Office	Field		General	Schools	Theatre								
Alabama	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
*Connecticut	.....	.....	.....	3,976	.....	618	.....	.....	10	3	.....	.....	.....	.....
District of Columbia	1	3	.....	30,658	.....	13	.....	.....	2	1	9	58	.....	.....
Georgia	1	.....	79	.....	.....	.....	.....	.....	20	2	.....	.....	.....	.....
Illinois	11	24	510	14,485	765	600	15,323	100	75	37	275	.....	30	150
Indiana	3	9	.....	‖24,052	.....	.....	17,627	①305	41	13	.....	.....	72,176	20
Iowa	1	3	257	612	.....	.....	241	113	35	24	95	.....	10,000	40
Kansas	3	3	300	12,573	150	.....	257	None	23	11	93	.....	40,000	30
Kentucky	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
†Louisiana	.....	.....	4	1,142	.....	.....	925	.....	30	3	.....	.....	.....	1
Maine	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Massachusetts	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Michigan	4	6	.....	884	174	§1,200	1,058	93	31	16	120	234	30	4
Minnesota	3	6	506	6,309	189	185	2,813	441	25	13	.....	.....	③	15
Mississippi	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Montana	1	.....	.....	.....	.....	.....	.....	118	1	1	2	.....	.....	.....
Nebraska	1	6	388	18,203	.....	.....	560	.....	2	2	47	74	④	10
North Carolina	3	6	121	¶	.....	.....	.....	.....	30	19	324	.....	467,550	400
North Dakota	1	2	240	3,004	112	75	158	26	6	2	.....	.....	None	.....
Ohio	15	28	1,738	10,541	1,518	312	10,501	5,049	118	93	84	.....	46	26
Oklahoma	.....	.....	4	.....	.....	.....	.....	.....	25	5	72	.....	.....	.....
Pennsylvania	12	‡2,054	.....	3,060	.....	.....	100	33	71	45	.....	.....	282,000	11
South Carolina	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
South Dakota	1	2	250	.....	.....	.....	200	150	20	4	.....	.....	12	.....
Tennessee	.....	.....	.....	289	.....	.....	119	.....	46	17	.....	.....	.....	.....
Texas	15	29	479	39,069	.....	.....	10,578	.....	16	1	.....	.....	50,000	19
Virginia	9	1	19	8,809	.....	.....	2,016	②3	.....	.....	.....	.....	.....	.....
West Virginia	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wisconsin	2	7	362	3,950	175	125	1,225	30	33	19	.....	.....	12	10

*Data covers all activities of State Police.
†1915.
‡Includes employes in all cities and towns.
‖Not classified.
¶All cities and towns.
§Moving Picture Theatres.
①97 Razed.
②Razed.
③2 Bulletins every month.
④1500 Bulletins a month.

Loss of Life from Common Hazards.

The subjoined newspaper extracts, culled at random, speak for themselves:

CHEYENNE, Wyo.—A recent fire in the Inter-Ocean Hotel resulted in the death of one man by electrocution and five men by suffocation. The elevator boy discovered the fire in the evening, about 9:35 o'clock, and the manager and employees tried to extinguish the blaze without calling the department, and the alarm was sent in at 9:59 o'clock by a passing pedestrian who saw the flames. From reports it appears that had the department been called when the fire was first discovered the lives would not have been lost and very little damage to the structure or its contents would have resulted. The hotel was a three-story structure constructed of soft brick and wood, and it occupied a space 132 by 66 feet. It was 41 years old and had partition walls, all made of wood, plaster and lath, except one, which separated the office and saloon, and this was of brick. The fire started in the public bath room on the third floor at the head of the stairs, and was caused probably by defective wiring.

SALAMANCA, N. Y., Feb. 9.—Five persons were burned to death when fire destroyed the farmhouse of Robert Woodard in Morgan Hollow, near here, early today. The dead are Robert Woodard, 75 years old; Mrs. Alfred Holmes, 61; Bergen Robbins, 12; Marie Robbins, 8, and Mabel Woodard, 2 years.

All of the occupants of the house were asleep when the fire started in the dining room, where some blankets were being dried out before a stove. So rapidly did the building burn that escape of the five was cut off. Three others who were in the house got out safely.

SASKATOON, Sask.—Two lives were lost the night of February 12 when fire completely destroyed the hotel at Elstow, Sask. Anton Leier, 28 years old, a grain buyer, was burned to death in his room, and the 9-months-old son of George W. Dunn also perished. The fire started from an oil lamp. The loss was $10,000.

WOONSOCKET, R. I., Feb. 19.—Miss Elizabeth F. Calhoun, an invalid, was burned to death in her wheel chair today. It is believed she was poking the kitchen fire when a live coal fell on her dress, igniting it.

TILTON, N. H., March 20.—Two men, returning home from work last night, discovered what they thought was a grass fire near the home of Mrs. Mary Dow Haines on Franklin Road. Rushing to the spot, they found that the woman's clothes had been set afire when her home burned to the ground and that she had run out in the field. She died of her burns this morning.

She lived in the house with only a dog to keep her company. It is believed that her canine friend, in jumping to her side, upset a table, sent a lamp crashing to the floor, and thus indirectly caused his mistress's death.

BROCKTON, Mass., March 23.—The bodies of George C. Reynolds, 76 years old, and Charles Smith, 50, were found in the ruins of Reynolds' house after fire had almost destroyed the building today. It is supposed that Reynolds fell on the stove and his clothing became ignited, starting the fire.

PARKERSBURG, W. Va., March 27.—Three persons were burned to death in a fire which destroyed the Stephens Hotel and 10 other buildings at Creston, Wirt County, early today. The fire originated in the hotel and is believed to have been caused by a leaking gas pipe. The loss was estimated at $75,000.

HUTTING, Ark., March 29.—In his foolish attempt to start a fire with gasoline, G. W. Howell is responsible for the death of Mr. and Mrs. John Q. Barlow and their daughter, Arcola, twenty years old, the parents and sister of Mrs. Howell. In combining gasoline with fire, an explosion followed, throwing gasoline over the beds in which three were sleeping, and they had no chance to escape. Howell himself was saved by jumping into the river, on which his house is located.

WINCHENDON, Mass., April 10.—Mrs. Adelaid Pierce, 80 years old, was burned to death in her home, three miles from the village, late this afternoon. She was alone in the house at the time, her son, George, with whom she lived, being away at work. Mrs. Pierce was preparing the evening meal and had filled the kitchen stove with wood.

Sparks set fire to her clothing and to the woodwork of the room. Mrs. Pierce evidently was unable to beat off the flames, and when the firemen arrived she was dead.

BOSTON, Mass., June 4.—Arthur and Martha Connolly, 2-months-old twins, placed by their mother yesterday in a basket on the roof of their home at 1107 Columbus Avenue, were cooing softly in the sunshine, when a spark from a passing locomotive fell into the basket and set fire to it. Martha died late yesterday afternoon at the City Hospital, and it is feared that her brother will not live.

After Mrs. Connolly had placed her babies on the roof, she returned to her apartment to do some housework. A few minutes later her eldest child, Thomas, 6, went to the roof to play with his brother and sister, and found their basket afire.

One of the principal aims of the fire preventionist nowadays is to secure psychological effects. If he could devise an "alarm system" which would be only half as efficient in drawing the attention of the American people to their terrible fire waste as are his mechanical devices in notifying the presence of fire in their vicinity, he would be more than satisfied.

Arrays of figures, however appalling, are not likely to produce any great effect in these days, but the value of the human touch is as great as it ever was. Such incidents as those listed above may, we believe, be most effectively used at fire prevention meetings and by teachers in the schools to drive home the general arguments for taking the American fire waste seriously.

An appeal has already been made through the *News Letter* to members to send clippings of this sort to the Executive Office of the Association, in order that the list may be made as comprehensive as possible. It will be observed that a majority of the deaths listed above occurred in one section of the country. With the co-operation of members it is hoped in time to compile a thoroughly representative list.

Spontaneous Combustion.

By G. H. P. Walker,

Electro-Chemist, Canadian Salt Co., Ltd.

Paper at Convention of Dominion Association of Fire Chiefs.

The subject of spontaneous combustion is essentially a chemical subject and involves considerable data of a technical nature, but the writer has endeavored to avoid chemistry as much as possible in order that the paper might possess a more or less practical value.

The phenomenon of combustion has been known since the earliest times, although the artificial production of fire is of comparatively recent date. Fires caused by lightning, volcanic eruptions and the spontaneous combustion of substances in nature were probably the first to be recognized by mankind, and it is no doubt from one or other of these natural sources that man first obtained fire. It is a well-known fact that among the ancients fire was always kept smouldering, and when a tribe travelled from place to place the fire was carefully carried along. This custom is still practiced by certain Australian races.

Fire was first produced artificially in the South Sea Islands by an ingenious native who obtained the necessary ignition temperature by rubbing two pieces of wood together. This marked a most important event in the history of the human race and placed at man's disposal a most powerful agent. It is not strange that many attributed it to a divine source, and hence arose the fire-worshippers, who still survive among Eastern nations. Plutarch states that as late as 100 A. D. there were races in existence who had no knowledge of fire.

The next step in the artificial production of fire was by means of the flint, and a little later, when scientists began to study this phenomenon, our modern match was developed, the ignition of which was originally accomplished by dipping the end (on which a little chlorate of potash and sulphur were cemented) into a vessel of sulphuric acid.

Another very simple source of fire is seen in the ordinary magnifying glass which condenses the sun's rays, producing quite a high temperature. The electric current also may be used to produce fire. In fact, the electric arc is capable of producing the highest temperature yet obtained through scientific research.

Apparently little was known about spontaneous combustion in early times, and even today it is but slightly understood; yet there can be no doubt that many conflagrations whose origins still lack satisfactory explanation might rightly be attributed to this cause.

When we speak of spontaneous combustion we usually refer to that peculiar form wherein ignition takes place without evidence of the employment of any external agent. For example: there is a striking difference between the spontaneous bursting into flames of a pile of coal and the ignition of that same coal under a boiler. It is the former type of combustion which we wish to consider in this paper. When ignition has taken place combustion follows the same laws whether of spontaneous or other origin, and these laws always represent more or less

complex chemical actions. Almost all chemical actions are attended with the liberation of considerable heat, and the quantity of heat set free is constant whether the action be relatively slow, as in the decaying of a piece of wood, or whether it be rapid, as in the combustion of a similar piece of wood in a furnace, the products of combustion being identical in either case. Combustion, as we usually understand it, is the union of a substance with oxygen, but in chemistry we have numerous instances of combustion where oxygen is not involved at all. The velocity of combustion increases with marvellous rapidity with rise of temperature, a rise of 200° F. increasing the velocity one thousandfold.

But since this paper has to deal not so much with the results as with the causes of fires, we will turn now to a consideration of a few of the more common forms in which spontaneous combustion manifests itself.

Of these, perhaps one of the commonest is the spontaneous ignition of a piece of cotton waste or an old rag, saturated with oil and left lying in a warm place. Only certain oils possess the property of spontaneously igniting, and of those the most dangerous is linseed oil, the boiled variety being much worse than the raw, due to slight changes in its chemical structure which have been effected by the boiling, and due also to the presence of certain metallic salts (such as lead acetate, litharge and manganese dioxide), which tend to accelerate the process of "drying" by acting as oxygen carriers. Other oils which are subject to spontaneous ignition are hempseed oil, poppyseed oil, nut oil, and, in fact, any rapidly drying vegetable oil, the action of so-called "drying" being the cause of the ignition. Mineral oils are not generally considered to be dangerous in this respect, and sometimes a mineral oil is added to one of the above rapidly drying oils to lessen the danger of spontaneous ignition if left exposed to the air absorbed in a cloth or anything of a spongy structure which furnishes a relatively large area of exposed surface. When spontaneous combustion results from an oil-soaked rag (or an oil mop, for instance) having been left carelessly in a warm room or in the sun, it is caused by the rapid oxidation of the oil spread out over the large surface afforded by the folds of the cloth—the greater the exposed surface the more rapid the oxidation—and as the oil continues to combine with more and more oxygen from the air the temperature gradually rises until sufficient heat has been developed to cause the mass to burst into flames. An excellent example of this rapid oxidation may be seen in linoleum works where linseed oil is made to drip over the surfaces of vertically suspended sheets of specially prepared cheese cloth. In so doing the oil becomes oxidized by contact with the air and gradually builds up a tough rubbery mass on both sides of the cheese cloth. This substance is called linoxyn, and is used as a binder in the manufacture of linoleum. It is also ground with cork dust to produce cork carpet. The oxidation of the oil is regulated so as to prevent the action becoming sufficiently rapid to cause spontaneous combustion.

The reason why a can of linseed oil does not burst into flames when left uncovered is that the small surface exposed to the air cannot develop heat with sufficient rapidity to raise the whole body of the oil in the can

to the temperature of ignition. Oxidation, however, does take place, as may be seen on the surface of the oil after having stood exposed for some time. This action of drying renders these oils very valuable as paint oils, but it also introduces a grave danger of fires being produced due to the spontaneous combustion of the oils.

It is interesting to note that paint oils do not dry in the sense that water or gasoline will evaporate or dry up, but their drying consists in the oils absorbing oxygen from the air, as above mentioned, to produce a substance of a solid nature in place of the liquid oil. Thus they gain in weight on drying, while water and gasoline lose in weight, and, in fact, finally disappear altogether.

Great care should be exercised in paint and oil works where such oils are liable to leak out and come in contact with old rags, waste or other absorbent material. Numerous instances might be cited of fires having started in new houses just after the floors had been oiled—the origin in each case having proved to be the mop or cloth which had been used to apply the oil.

The dangers resulting from the spontaneous combustion of oils are to be found in many industries where drying oils are employed. In tanneries the oils used for dressing the leather frequently oxidize with sufficient rapidity to take fire. In fact, freshly oiled leather is liable to ignite if left in a warm place, as near a steam pipe or heater. Here we have practically the same reaction as with the linseed oil on the mop. Another instance worthy of note is in cloth mills where oil is added to the wool before spinning, and particularly in the preparation of shoddy. If such oil-treated goods are piled where ventilation is poor, the oxidation of the oils may raise the temperature sufficiently to cause the pile to ignite.

In the charring of certain kinds of wood in the preparation of charcoal there is considerable danger of spontaneous combustion. It is a well-known fact that charcoal, being of an exceedingly porous nature, has an enormous capacity for absorbing certain gases. Good charcoal made from boxwood will absorb ninety to one hundred and seventy times its own volume of ammonia, sixty-eight times its volume of carbon dioxide, and eight to eighteen times its volume of oxygen. Freshly made dogwood charcoal absorbs oxygen so fast that it often bursts into flames spontaneously. For this reason, after charring, it has to be set away for a couple of weeks to permit it to slowly absorb moisture and air before being ground to be used in the manufacture of the higher grades of gunpowder.

The slaking of lime is a process well known to everyone, and yet few realize that here also lies a danger of spontaneous combustion. When water is added to quick lime it chemically unites with the lime with the evolution of large quantities of heat. If the action takes place in an enclosed space (a boxcar, for instance, or a bin) where the heat cannot dissipate readily, a temperature as high as 750° F. may be produced, thereby causing any wood or other readily combustible material close at hand to ignite. Few people realize that lime shipped in a car with a leaky roof may cause the car to burst into flames if the lime be very pure or "fat," as it is frequently expressed. Farmers have been

known to have their wagon-boxes charred when driving home in a shower of rain with a load of lime. Many of us have not actually experienced such phenomena, but there can be no doubt as to the authenticity of these facts.

In the purification of coal gas by means of hydrated ferric oxide (a special oxide of iron) the ferric oxide removes certain sulphurous impurities (such as sulphuretted hydrogen) and gradually changes over to iron sulphide. This iron sulphide is then exposed to the atmosphere, where it oxidizes, liberating sulphur and changing back to ferric oxide. During this chemical action considerable heat is generated, and if the action is permitted to go on too rapidly, the mass may ignite spontaneously. Here again we have an excellent example of spontaneous combustion caused by simple exposure of the substance to the atmosphere.

In industries where steam power is extensively developed, considerable difficulty is sometimes experienced in the storage of bituminous or soft coal. Certain varieties of soft coals are much given to spontaneously igniting when stored in large quantities. The usual cause of such ignition is the presence of iron sulphide in the coal. Some coals contain as high as two to five per cent of this impurity, which may occur in either of two forms, namely,—pyrite, being a yellow variety, exceedingly hard and not a particularly dangerous impurity; and marcasite, a white sulphide which is much more prone to oxidation, especially in a damp atmosphere. When soft coal containing sulphide impurities is stored in large quantities and more or less exposed to dampness, the iron sulphide slowly oxidizes, yielding iron sulphate and sulphuric acid with the liberation of considerable heat. If this heat be not carried away by suitable ventilation, a high temperature is created and ignition of the coal results. Such fires are very difficult to extinguish and necessitate the moving of a large portion of the coal, at the same time thoroughly quenching it with a hose. Not only is sulphur (present in the sulphides of iron) objectionable from the standpoint of spontaneous combustion, but it also renders coal very undesirable for domestic purposes, the sulphur being given off as an oxide, or burning, and eventually producing sulphuric acid, which is injurious to articles of the household, especially leather, and to surrounding plant life. It also causes corrosion of the grate bars and furnace fittings.

Some cases of spontaneous combustion in coal have occurred which could not be attributed to the presence of pyrites. In these instances the cause has usually been assigned to the power which some coals possess of absorbing and condensing in their pores the gases of the atmosphere, thus producing heat and ignition, as already mentioned in the case of freshly ignited charcoal. Then, too, any organic matter other than the coal itself which may be present seems to suffer oxidation particularly when warmed in contact with air, and this also augments the tendency to spontaneously ignite. It is worthy of note that while moisture favors the oxidation of iron sulphides in coal, it retards the action of coal in absorbing oxygen, so that it is necessary to know the chemical properties of the coal in order to determine the cause of its spontaneous ignition. In either case the danger is lessened by good ventilation whereby the heat may be removed before the temperature of

ignition is reached. On the other hand, no ventilation is preferable to a limited access of air which often favors spontaneous combustion.

Acetylene, which is the gas given off when calcium carbide comes in contact with water, is in some respects subject to spontaneous combustion. The pure gas is not dangerous, but commercial carbide usually contains impurities which give rise to the production of other gases besides acetylene. Of these, the most dangerous are phosphuretted hydrogen and siliciuretted hydrogen, the one a phosphorus compound and the other a compound of silicon and hydrogen. Both gases are poisonous and both are liable to burst into flame on coming into contact with air. This fact may account for some of the explosions in acetylene generators, even in the absence of a jet or any external means of igniting the gas. The white haze which is often seen in rooms lighted by acetylene is attributed to the formation of phosphorus pentoxide—a white powder which is formed on burning phosphuretted hydrogen and which settles very slowly. Pure acetylene has a pleasant ethereal smell, the impurities producing the unpleasant odor with which most of us are familiar.

Mixtures of acetylene and air are much more readily ignited than are mixtures of coal gas or water gas and air. A glowing cigar is sufficient to ignite acetylene air mixtures. This gas is not particularly dangerous if handled at atmospheric pressure, but when compressed or liquified it is more dangerous, and a sudden jar or a detonation near by is often sufficient to cause it to explode. In the storage of calcium carbide great care must be observed to prevent contact with moisture or damp air which will liberate acetylene. If the liberated gas cannot escape readily high pressures may result and finally serious explosions. About one-tenth as much acetylene as coal gas is sufficient to form an explosive mixture with air, and the explosive range of such a mixture is very wide, ranging from three per cent to eighty-two per cent acetylene.

In warehouses where chemicals are stored certain precautions should be observed in order to prevent accidental contact of chemicals which spontaneously ignite when mixed. For instance, potassium or sodium chlorate should not be stored where there is any possibility of sulphuric acid leaking out and coming in contact with them, for sulphuric acid has a great affinity for chlorates, giving rise to considerable heat—in many cases sufficient to ignite wood. A fire occurred some time ago from this cause—the sulphuric acid was stored in carboys on a loft under which were piled several sacks of chlorate. Some of the carboys became cracked and the acid, running down over the chlorate, set fire to the warehouse, resulting in considerable loss of chemicals. Concentrated nitric acid, if brought into contact with dry organic matter, produces rapid oxidation and may raise the temperature of the mass to the ignition point. Dry straw, sawdust, and packing materials in general are particularly subject to ignition on contact with nitric acid, and great care should be taken in packing this acid to prevent spilling. When we recall that nitric acid is an important constituent of picric acid, nitro-benzol, gun-cotton, nitroglycerine, dynamite and numerous other high explosives, we begin to realize that it is a dangerous chemical with which we are dealing. The chlorates resemble nitric acid and nitrates somewhat, but

are more susceptible to friction. Potassium chlorate may be ignited by stepping on some of the powder mixed with dust or other finely divided combustible. Sodium and barium peroxides may effect ignition in the same manner.

In textile works where the processes of mercerizing and weighting of fabrics are carried on, certain heavily weighted silks, when very dry and closely packed, are subject to spontaneous combustion. The cause of this is not thoroughly understood, but when we reflect that weighting is often done by the addition of such substances as tannic acid and tannates, together with iron salts, which are very susceptible to oxidation, and consequent heating, we can at least approach an explanation of this phenomenon in that the iron salts and tannates take up oxygen from the air with such rapidity that sufficient heat is generated to ignite the fabric. Black silks are more readily ignited than colored silks, due to their larger content of oxidizable coloring matter. An unweighted silk is not dangerous in this respect.

In the dyeing of fabrics where potassium chlorate is used as the oxidizing agent there is considerable danger of fire, due to the rapid oxidation of the aniline dye of the chlorate. We have already seen that chlorate in the presence of a strong acid is very liable to produce fire, not only by the heat evolved during the action, but also by the liberation of chlorine peroxide, which is a highly explosive gas and a powerful oxidizing agent.

Bacteria or micro-organisms are sometimes responsible for fires, the heat being produced by fermentation or putrefaction. Although the temperatures produced by such actions are not high, yet if the heat cannot escape a gradual rise in temperature results, which in turn accelerates the fermentative action and may cause the ignition point to be reached. An excellent example of such heating is afforded in heaps of stable manure or in tanner's refuse. Here the heat cannot escape and the centre of the mass may reach a relatively high temperature. Any form of decaying organic matter may give rise to a similar effect in the absence of ventilation. Such heat, of course, could never be obtained if the mass were loosely piled so that air could freely circulate. On a larger scale this heating action is frequently observed in hay stacks when the hay has been put away green or imperfectly dried. The micro-organisms so plentiful in grass and hay act upon the fibres of the hay, producing oxidation and consequent heating (the initial heat developed by the organisms is not high, for most bacteria are destroyed below 212° F.) Here again a free access of air would prevent undue heating by allowing the heat to escape as fast as it is generated; or if the hay were pressed into bales and the air thoroughly squeezed out from the interstices, heating would be prevented. It is the presence of a *limited amount* of air that causes the heating. On the other hand, it is not always desirable to entirely prevent fermentation, for by this means the aroma, flavor and color of the hay are improved. The addition of salt is frequently the only precaution a farmer takes when storing away his winter supply of hay. The salt retards the action of the bacteria and renders the hay more palatable.

Electric sparks caused by friction may ignite volatile solvents such

as ether, naphtha or benzine, as in dry-cleaning establishments. Fires have actually been known to originate from the friction of rubbing benzine-soaked goods in a cleaning works, although such occurrences are rare. Some years ago a forty-gallon tank of naphtha became ignited in a cleaning works in France. One of the men threw a bottle of liquid ammonia into the tank and the result was marvellous, the fire being almost instantly smothered by the ammonia fumes. In this case water would have been of little use.

Another similar fire occurred in a ladies' hair-dressing parlor, where petroleum spirits were being used. The eminent scientist, Lord Kelvin, attributed this fire to the ignition of the spirit vapors by an electric spark from the brushing of the hair—no other source of fire being present.

Finely divided particles of any combustible substance suspended in the air are subject to rapid combustion if ignited from an open flame, a hot bearing, or other cause, as in flour mills, cork grinding works or coal mines, where fire damp is not always responsible for the disastrous explosions which occur from time to time. Such fires might often be prevented or rendered less violent by keeping the atmosphere damp in order that the dust might tend to settle. In some works solutions of calcium chloride (a by-product from the ammonia-soda process) are sprayed on the floors. The calcium chloride, being of a deliquescent nature, absorbs moisture from the air and tends to keep the floor damp, thus causing dust particles to adhere and settle more readily. This solution is sometimes used on the streets to keep down dust.

Combustibles of vegetable origin are much more prone to ignition than those of animal origin, since they all contain cellulose in one form or another. Chemically speaking, cotton, linen and flax are almost identical with wood, all being made up largely of cellulose. Frequently it is desirable to render such substances fireproof where woven into fabrics. It is not practicable to make them thoroughly fireproof for a continued exposure to intense heat unless the materials consist of asbestos, but by treating them with solutions of certain salts, as, for instance, alum, ammonium sulphate or phosphate, borax, water glass (being a soluble silicate of sodium), calcium chloride or sodium tungstate, and allowing those salts to crystallize in the pores of the fabrics, temporary fireproofing may be accomplished. The effect is simply to produce on the fabrics a coating which can resist a short application of intense heat without igniting, or which will liberate volumes of gases (ammonia or steam) incapable of supporting combustion. These gases produce a smothering effect on the flames in proximity to the fabrics and prevent their taking fire.

A mixture of three parts borax, two and one-half parts epsom salts and twenty parts water makes an excellent fireproofing solution, but must be applied as soon as prepared, the borax and epsom salts being first dissolved in separate portions of water. Most of the above mentioned salts may also be employed in the fireproofing of wood.

To quench a fire, one of two things is necessary. Either the temperature of the burning substance must be reduced below the ignition point, or the air or gas which support the combustion must be excluded.

In practice both methods are employed, the former by a liberal application of cold water and the latter by the use of sand, textile fabrics (a coat or a quilt is often used in checking domestic fires), saline solutions or chemicals.

Of the saline solutions, probably the most used is a solution of sodium bicarbonate (baking soda) in water, to which sulphuric acid may be added by inverting the glass jar within the container. The acid reacts with the bicarbonate to liberate carbon dioxide—an inert gas which will not support combustion—and this gas dissolves in the water and is forced out through the nozzle into the fire, where it has a slight smothering effect, while the water acts in the usual way. Chemical fire engines operate on this principle.

One form of chemical apparatus is the small, one-quart extinguisher, which contains a heavy volatile non-combustible liquid called carbon tetrachloride. This liquid is applied by forcing it through a nozzle by means of a piston, and is unsurpassed for quenching burning gasoline, naphtha or benzine. The vapors of carbon tetrachloride, being inert, smother the flames where water would be of little or no avail. Extinguishing powders, consisting of a mixture of saltpetre, sulphur, charcoal and resins or similar substances, act by giving off dense fumes, which fill the area surrounding the fire and prevent access of air. Obviously such powders may be utilized effectively only within an enclosed space.

Summarizing, we might say that some of the most fruitful sources of spontaneous combustion are to be found in the oxidation of certain rapidly drying oils where spread out on waste, rags, etc.; the oxidation of iron pyrites in soft coal; the slow oxidation of heaps of organic matter, as manure and hay; the absorption of gases by porous bodies, such as charcoal and powdered slack coal. In the above cases thorough ventilation or else none at all is to be recommended, a moderate or sparing admission of air tending to accelerate rather than to retard the action. As an example, we might mention the case of four ships carrying coal containing pyrites impurities to India some years ago. Of these, three were moderately ventilated by air shafts, and the fourth had no provision for ventilation. The ventilated ships were destroyed, due to spontaneous combustion of the coal, whereas the unventilated ship reached its destination in safety. If the coal is not thoroughly ventilated it should be packed as tightly as possible to prevent shifting about and grinding on board ship, for the finer the coal the more liable it is to heat and ignite.

As other sources of spontaneous combustion already referred to may be cited,—the slaking of lime, which is purely a chemical action and which gives rise to considerable development of heat; the action of nitric acid and other strong acids on organic matter (such as straw and shavings), the interaction of sulphuric acid and chlorates, the action of water on calcium carbide, sodium peroxide, and sulphuric acid, and the electric spark.

Concentrating Fire Stream Connections.

A practical plan for installing hose connections in limited space.

By Charles E. Worthington

(Member N. F. P. A.)

In practice we not infrequently encounter situations where good fire protection is essential, but where no standard form of apparatus appears to be completely applicable.

To meet the needs of such cases special apparatus must be devised, which will avoid the obstacles that bar the use of standard forms and yet in all essential features will not fall below the recognized standards.

A case of this sort is the provision in Boston of connections for eight standard fire streams in a railway train shed.

The number to be concentrated was too great to permit of ordinary standpipes, for which also no place could be found and no satisfactory means of first aid.

Lowry hydrants were hardly practicable since proper chucks could not well be provided and the fire department chucks were quite unsuitable.

The plan finally adopted was to provide for an eight-inch main carried under and across the shed and connecting to 12-inch mains at both ends with gate valves at the points of connection.

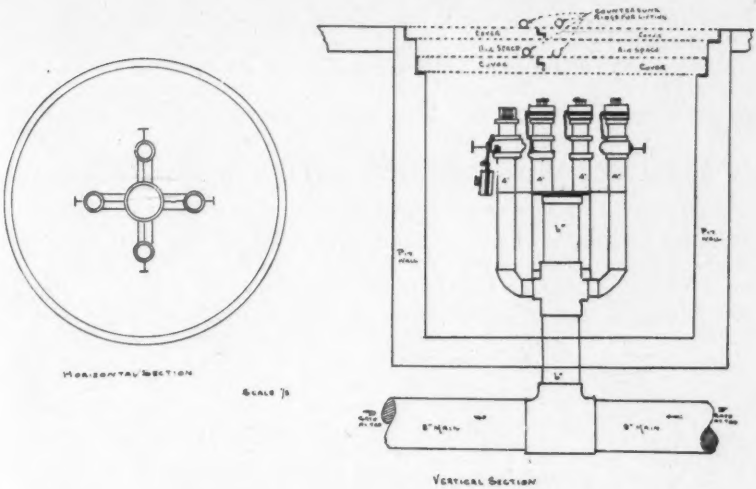
From this 8-inch main are to be taken two six-inch risers, to be carried up in frost proof pits branching to four 4-inch uprights terminating in gate valves and threaded and capped ends. The central riser is carried up above the branches both as a cushion chamber and a place for attaching rod stays from the four-inch risers.

Pits are to be located under the concrete platforms or foot walks and are to have double covers with an air space. Covers to be divided in one diameter to facilitate lifting and also provided with counter-sunk rings for the same purpose, the general arrangement being shown in the sketch below.

This is designed for both private and fire department use, especially the latter, upon whose especial request the installation was designed.

This plan would seem equally suitable for other situations where the space consists, for instance in railroad yards, of narrow roadways between tracks, inaccessible to steamers.

Post hydrants are entirely impracticable in many of these situations and as Lowry hydrants would involve provision of many specially designed chucks these can hardly be considered. Hose, however, can usually be provided within a reasonable distance or



area. Ordinarily there would be *two* 4-inch risers instead of four, and gate valves controlling the pit hydrants by groups where special control cannot be had separately.

This sketch and description are not offered with any claim for any special merit, but merely as a suggestion of a possible practical solution of the difficulties arising in some not unusual situations.

Non-Freezing Liquids for Fire Protection.

Journal American Society of Refrigerating Engineers.

The Committee on Automatic Sprinklers of the National Fire Protection Association met on February 19, 1917, in New York City to consider the use of liquids having low freezing points for filling the piping of automatic sprinkler systems exposed to low air temperatures in winter or in mechanically refrigerated rooms. In the absence of Louis K. Doelling, Chairman of the Committee on Municipal and State Regulations for Refrigerating Plants and Refrigerants of The American Society of Refrigerating Engineers, Charles H. Herter was requested to represent the society at this meeting.

The two liquids which were suggested in this connection are (1) chloride of calcium brine and (2) glycerine and water solution.

In Bulletin No. 3-A, March, 1911, entitled "Chloride of Calcium as a Non-Congealable Fluid for Fire Protection," the Carbondale Calcium Company, Carbondale, Pa., recommended Cl_2 as a desirable medium with which to fill fire pails and automatic sprinkler systems. This bulletin gives the data in Table 1 as to quantities of "3 C" 73 to 75 per cent granulated calcium chloride necessary for preparing solutions of the strengths and freezing points indicated:

Table 1 (Carbondale)

Specific Gravity	Calcium Per Cubic Foot of Solution	Calcium Per U. S. Gallon of Solution	Freezing Point °F.
1.100	10.70	1.43	18.5
1.125	13.47	1.80	13.3
1.150	16.26	2.18	7.5
1.175	19.15	2.56	0.
1.200	22.05	2.95	— 8.7
1.225	25.06	3.36	—19.5
1.250	28.06	3.76	—32.6
1.261	30.00	4.01	—39.28
1.272	31.30	4.18	—46.20
1.283	32.70	4.37	—54.40

During 1916 the Committee on Automatic Sprinklers, under the Chairmanship of C. L. Scofield, Montreal, Canada, gathered information on the advantages and disadvantages of liquids having low freezing points, and information was furnished by various members of The American Society of Refrigerating Engineers.

The substance of Mr. Herter's remarks was that pure, commercial calcium chloride was entirely suitable, in so far as freedom from congealing and precipitation was concerned, but that the presence of dissimilar metals in sprinkler lines in contact with brine was cer-

tain to induce electrolytic action and cause wearing away of brass parts. Also that a special compound, such as shellac or litharge and glycerine, instead of red lead, should be used in making screw thread joints, and that, owing to the affinity of calcium chloride for moisture, leaks spring up readily, the absorbed moisture favoring corrosion about the leak, often undetected.

In answer to Mr. Scofield's question as to the length of life of iron and steel brine pipe, it was stated that the majority of refrigerating engineers still prefer wrought iron to steel pipe, although tests conducted with steel pipe by the National Tube Co. seemed to prove that its steel pipe endures as well as iron pipe, and that some pipe in brine tanks has been in service for 25 years, while in other cases piping exposed to salt brine had to be discarded after six years' use.

The graphite-like substance found inside of calcium brine pipes was believed by Mr. Herter to consist of scale in pipe, rust and residue of lubricating oil. It may also be found where salt brine has been replaced by calcium brine. Brines should always be neutralized and made alkaline by the addition of one to two pounds of carbonate of soda per 100 pounds of salt, and one-half pound hydrate of soda per 100 pounds calcium used.

G. D. Avery and R. T. Dutton, representing the Carbondale Calcium Co., stated that in view of long experience gained, their company has discontinued offering calcium for sprinkler systems owing to corrosion being induced when the brine comes in contact with different metals.

Mr. Herter further stated that if the sprinkler heads could be made of some other metal than brass or bronze, the use of aqua ammonia might be considered. Owing to its nitrogen content, aqua ammonia is said to be effective for retarding fires. The objection to ammonia odor would be largely removed by the action of the sprinkler water following the aqua, only a small quantity being necessary to absorb all of the ammonia vapor present. Furthermore, cold aqua ammonia vapor does not affect the respiratory organs as severely as does warm anhydrous ammonia. Aqua ammonia being alkaline has no effect on steel, iron, lead, aluminum or some aluminum alloy.

The following, Table II, was offered as giving the freezing points of aqua ammonia of various strengths:

Table II (Goettsche.)

Specific Gravity at 59° F.	Percent of Solution	Degrees Baumé	Freezing Point °C.	Freezing Point °F.
0.960	9.91	16	— 8.7	16.34
0.945	14.17	19	—13.2	8.24
0.930	18.64	22	—18	— 0.40
0.925	20.18	23	—21.8	— 7.24
0.920	21.75	24	—25.3	—13.54
0.895	30.03	29	—44	—47.2

In cases where miscellaneous metals are used in a system, and where the temperature surrounding sprinkler pipes does not fall below zero Fahr., Mr. Herter said a 50 per cent solution of glycerine

could be used if the expense was not prohibitive. He offered the following two tables of freezing points, their variation indicating either a difference in the quality of the glycerine tested, or a wide difference in the interpretation of what constitutes the actual freezing point, it being well known that at low temperature the solutions thicken; but, even when frozen, the congealed mass remains soft, forming a mush, and making it difficult to designate any one temperature as the real freezing point:

Table III (Goettsche.)

Glycerine Content %	Specific Gravity	Freezing Point °C.	Freezing Point °F.
10	1.024	— 1	30.20
15	1.036	— 1.7	28.94
20	1.048	— 2.5	27.50
25	1.060	— 4.3	24.26
30	1.073	— 6.0	21.20
35	1.086	—11.0	12.20
40	1.099	—17.5	+ 0.50
45	1.112	—24.5	—12.1
50	1.125	—31.3	—24.3
55	1.139	—40.	—40.
60	1.152	Below	Below
70	1.179	—40.	—40.

Tables II and III are taken from "Kalender fuer Kaelte-Techniker," 1912, Georg Goettsche, Altona, Germany, pp. 66 and 43.

Table IV is taken from "Mechanical Engineers' Handbook," by L. S. Marks.

Table IV (Bolley.)

Glycerine Per Cent by Weight	Specific Gravity at 32° F.	Freezing Point °C.	Freezing Point °F.
10	1.0245	— 1	30.2
20	1.0498	— 2.5	27.5
30	1.0771	— 6.2	20.85
40	1.1045	—17.2	+ 1.0
45	1.1183	—26.2	—15.2
50	1.1320	—32.	—25.6
60	1.1582	Below —35.0	—31.0

Table V (Abegg.)

Glycerine=$C_3H_5(OH)_3$. Molecular Weight 92.06

Glycerine Per Cent by Weight	Pounds Anhydrous Glycerine Per 100 Pounds Water	Freezing Point °C.	Freezing Point °F.
4.7	4.925	— 1.02	+30.163
18.1	22.09	— 4.75	+23.45
30.7	48.24	—11.15	+11.92

The determinations in Table V are those given by R. Abegg in "Zeitschrift fuer Physikalische Chemie," Leipzig, Vol. 15, p. 217, 1894, as reported in Landolt-Boernstein's "Physikalisch-Chemische Tabellen," Berlin, 1905, p. 495.

Attention was called to a letter dated August 11, 1916, written to Mr. Scofield, Chairman of the Committee, by A. C. Langmuir, chief chemist of Marx & Rawolle, manufacturers of glycerine, Brooklyn, N. Y., giving freezing points and other data on glycerine. This letter read as follows:

"With reference to the suggestion of the Linde Canadian Refrigeration Co., of Montreal, as to the use of a mixture of glycerine and water for filling sprinkler pipes in cold storage rooms, we agree entirely as to the advisability and advantage in the use of such a mixture.

"Distilled glycerine is a smooth, rather heavy liquid of 1.26 specific gravity, weighing 10½ pounds per United States gallon of 231 cubic inches. The present price of distilled yellow glycerine, which would be the best product for this use, is 35 cents per pound. This figure is abnormally high, because of the use of large quantities of glycerine for war materials. During the period 1912 to 1915 this variety of glycerine ranged between 15 and 20 cents per pound, and we believe that under ordinary conditions 20 cents would be an outside limit to figure on a cost of this material.

"Glycerine cannot be ignited at a temperature less than its boiling point, which is 290 degrees C., or 554 degrees F. If it is mixed with water, the water must first be entirely boiled out, and the temperature of the remaining glycerine 554 degrees F. before it can be ignited. It then burns slowly and quietly without explosion. The table of freezing points below would indicate that a 40 per cent to 50 per cent mixture of glycerine and water would meet your requirements. Such a proportion of water would make this diluted glycerine an effective fire extinguisher. Glycerine can be mixed with water in any proportion by stirring and without application of heat. A mixture, once made, is permanent without any separation of glycerine. It is not subject to deterioration, does not ferment and is entirely neutral and without action of any kind on metals or rubber. If at any time the pipes should be drained, the material could be sold on the basis of the percentage of glycerine and the market value of glycerine at the time.

"We have made mixtures of glycerine and water in the following proportions, and by means of a mixture of liquid carbonic acid and ether have obtained the following freezing points:

Table VI (Langmuir.)

10	per cent glycerine gives freezing point of	26 degrees F.
20	" " " " "	22 degrees F.
30	" " " " "	14 to 16 degrees F.
40	" " " " "	3 to 5 degrees F.
50	" " " " "	—12 to —15 degrees F.
60	" " " " "	—28 to —30 degrees F.
70	" " " " "	about —45
80	" " " " "	—55 to —60 degrees F.

"The above mixtures represent percentage by weight, i. e., 10 per cent glycerine means a mixture of 10 pounds of glycerine and 90 pounds of water. When the concentration of the glycerine reaches

70 to 80 per cent the mixture becomes quite viscous at very low temperatures, and does not flow readily, but you would have no trouble of this kind with mixtures up to 60 per cent, and these mixtures should entirely satisfy your requirements."

Further data on the subject is contained in a letter dated September 29, 1916, written to Mr. Scofield by H. T. Barnes, Director of Physics, McGill University, Montreal, as follows:

"In order to test the fluidity of glycerine solutions one gallon yellow glycerine was obtained from Marx & Rawolle. Solutions of 40, 50, 55 and 61 per cent glycerine and water, weight for weight, were prepared and cooled by means of a bath of liquid air. These solutions were chilled to a temperature at which they congealed into a thick paste. The following observations were made:

"A 40 per cent solution congealed to a thick, white paste at + 6.8 degrees F. Crystals of ice began to appear at + 10.4 degrees F.

"A 50 per cent solution becomes a thick, almost solid, white paste at —15 degree F. Below —9 degrees F. separation of the ice crystals forming the paste appears to begin. At 0 degrees F. this solution flows readily, and would probably be serviceable down to —9 degrees F.

"A 55 per cent solution becomes a thick, white paste at —27 degrees F. Cloudy at —11 degrees F., and the paste appears to melt about —9 degrees F. At —7.5 degrees F. the solution is quite clear and fluid.

"A 61 per cent solution becomes very viscous at —22 degrees F., and a white deposit commences. The solution appears to be quite fluid at —16 degrees F., but could not be used below —20 degrees F.

"The 60 per cent solution would, I think, be sufficiently fluid to allow the ready entrance of the water to the pipes down to about —15 degrees F. I must, however, point out that any portion of that pipe containing glycerine solution which might be at or near a refrigeration coil, where it would be cooled down to a temperature of —20 degrees or lower, would be subject to stoppage by the transformation of the glycerine solution into a thick and highly viscous mass of crystals of ice. While I did not test stronger solutions than 61 per cent, I do not believe that these would be sufficiently fluid at these low temperatures to answer your purpose."

In a letter of February 5, 1917, and at this meeting, Dr. Langmuir pointed out that he had analyzed a sample of the same yellow glycerine that Professor Barnes had used and reported on it as follows:

Table VII.

Specific gravity	1.2385
Glycerine by acetin method	88.25 per cent
Organic residue at 160 degrees C.	0.45 " "
Ash	0.25 " "
Water (by subtraction)	11.05 " "

Also, that this grade was known in the trade as "high grade saponification crude glycerine," while the glycerine used in his tests was

practically anhydrous. If allowance is made for the initial water in Professor Barnes' samples, the same freezing points are supposed to obtain as those given by Dr. Langmuir, August 11, 1916.

Dr. Langmuir made various demonstrations at the meeting. He drank the pure water-white glycerine, the price of which is now above 50 cents per pound, to show its harmless character; he prepared a 50 per cent solution, and proved that (at room temperature of 70 degrees F.) it was still as liquid as turpentine, and he heated a solution in the platinum crucible to show that it would not be ignited until every trace of water has escaped in the form of steam, and even then it burned but slowly with a blue flame, readily extinguished with water. In a letter dated October 6, 1916, Dr. Langmuir advises using a 40 to 50 per cent solution, which would still be sufficiently fluid, and says that glycerine solutions would not be safe for temperatures colder than 15 to 20 degrees below zero F.

According to International Textbook Co., Scranton, Pa., Volume 16B, International Library of Technology, pure anhydrous glycerine has a specific gravity of 1.269; boiling point 290 degrees C. (554 degrees F.), but becomes inflammable when heated to 150 degrees C. (302 degrees F.) It is slightly volatile at 212 degrees F., but entirely stable at ordinary temperatures. A perfectly pure and anhydrous solution crystalizes on long exposures at —40 degrees F., the crystals melting again at + 1 degree F. Equal volumes of water and glycerine are used for filling gas meters.

Conclusions.

No definite conclusions appear to have been reached by the committee at this meeting, but the facts brought out were (**a**) that it is difficult to find an inexpensive and acceptable liquid to take the place of the so-called dry (air-filled) system; (**b**) that both calcium brine and aqua ammonia are inadvisable so long as sprinkler heads are made of brass, copper or bronze (**c**) that new non-corrosive metals or alloys should be experimented with to test their endurance with brine and steel pipe, and (**d**) that a glycerine and water solution up to 50 degrees strength seems to be entirely acceptable, provided the air temperature is not below —20 degrees F. Where required, the pipes should be insulated and no pipes used smaller than 1 inch.

Civil Service Examination Answers.

Some Extraordinary Answers Submitted in an Electrical Examination for State Factory Inspector, Whose Duties Include Electrical Inspection.

The *Electrical Review and Western Electrician* recently took the trouble to go through a set of Civil Service examination papers and examine the answers of persons taking the examinations. The editors state that while it is not their practice to publish articles of comic interest, the result of their inspection of these papers is published because of its forcible demonstration of the need for strict civil service examinations for any inspection positions involving a knowledge of electrical matters.

In one of our Western states the position of state factory inspector and deputy inspector includes among its numerous duties the inspection of electrical wiring and electrical machinery installed in factories. In this state, as usual, there is no separate corps of state electrical inspectors, consequently the factory inspectors are expected to have sufficient electrical knowledge to enable them readily to recognize any conditions of the wiring, motors, switches, etc., that are manifest hazards.

An examination for state factory inspector was held recently which included some twenty questions on simple electrical matters. These questions and typical answers are given below. They disclose the class of men that apply for state positions and which, in the absence of an examination, generally are selected to fill these positions.

Question.—What is the National Electrical Code? Describe fully.

Answers.—(a) Wireman's Bible—"Thou shalt not do this," etc. (b) The N. E. Code is laws enacted by the state governing electrical devices.

Question.—What is the difference between a positive and negative conductor?

Answers.—(a) The difference between positive and negative is that the one is intact at all times. (b) Return and discharge. (c) A positive conductor is direct current and negative is the reverse. (d) A positive conductor is one that absolves electric current. A negative is one that resists electric current. (e) A positive conductor is conducted by positive current, while a negative conductor is controlled by storage battery. (f) One is direct, the other indirect.

Question.—Name three defects that would cause sparking of brushes at commutator.

Answers.—(a) Lightning; breakage in main line; short circuit. (b) Too heavy voltage; too much oil. (c) Carbon; short circuits; defective wiring. (d) Improper wrapping of coils; worn commutator; loosening of screws or taps. (e) Wiring in bad condition; crosion of dirt and grit. (f) Dirt, oil or water. (g) Ear reglar frixshon, dirt and uneven power. (h) Dirt, chipped brushes and broken wire.

Question.—Name three conditions that might cause an electrical fire?

Answers.—(a) Defective wiring, insulation burned off, loose wires crossed. (b) A short circuit coming in contact with some foreign object. (c) In some cases

a wire becoming exposed to the weather that it might cause a fire in time. (d) When wires come in contact where the installation is off. (e) Improper casing for wiring. (f) Exposed wiring; carelessness.

Question.—Why do induction motors require a large starting current? When should both starting and running fuses be installed and when is it necessary to use autostarters?

Answers.—(a) A large starting current is required to avoid blow outs and necessary for starting requiring more power than when running. (b) Account wasted energy entering machine. (c) Being too heavy for a light current when a heavy current is to be used. (d) Because of indirect current, both starting and running fuses should be installed when motor is stopped. (e) Resistance is too great for low current. (f) On altering current autostarter is used when batteries are fully charged.

Question.—Name the following abbreviations: C. P., K. W., H. P., W., R., I., E., D. C., A. C., E. M. F., K. V. A., R. P. M.

Answers.—I—Indirect Current; A. C.—Alternation Current; E—Emphrie; C. P.—Current Power; I—Insolation; E—Electricity; D. C.—Dead Current; A. C.—Active Current; H. P.—High Power; W—Waste; R—Run.

Question.—What is the difference between alternating and direct current? Explain the process in which both currents are made, collected and transmitted.

Answers.—(a) Alternating current passes over wires in waves, direct current passes through wires direct. (b) Current from dynamo direct to machines or to the motor first and then to machine. (c) Alternation current is a power direct to commutator and is governed to a more even power; direct current is the power direct from the producer. (d) Alternating current is one what has been redust to a certain required voltshes; direct current being a current youst as received direct wit out any reduction in voltches. (e) Alternating current is by switch when needed for immediate service; direct is from motor to feed wires. (f) Direct current is on at all times and is the same while alternating current isn't the same at all times. (g) Alternating current has more power and more efficient than direct.

Question.—When the E. M. F. equals 220 V. and the current equals 20 A., what is the resistance? Define Ohm's Law.

Answers.—(There were only two answers out of thirteen. One was correct and the other only partially correct.)

Question.—Describe the manner in which you would install a 2,300 V. motor. Tell how you would protect all parts. This question should be answered from the standpoint of the life and accident hazard as well as fire hazard.

Answer.—Put a railing around it.

Question.—Define: Voltage, Circuit, Grounded, Automatic, Cutout, Guarded, Exposed, Accessible, Isolated, Conductor, Insulated.

Answers.—(a) Grounded—short in line. (b) Exposed—not insulated. (c) Circuit—necessary parts having the substance of electricity or the completed route as contemplated. (d) Cutout—to stop by switch or other means. (e) Grounded—detracted by or from the intended course. (f) Guarded—protected from exterior harm or the harm of the part. (g) Conductor—the magnetic value of any material in carrying electricity. (h) Insulated—the compulsory keeping of electricity on the intended route by tape, conduit or other materials. (i) Voltage—the amount of power. (j) Circuit—wiring. (k) Grounded—wires in contact with wiring. (l) Cutout—not in use. (m) Isolated—cover of wires. (n) Conductor—guides the current. (o) Insulated—wrapping. (p) Current—real power in it self. (q) Grounded—when electric wires come in contact with some outside object and

takes up all the power or even a part. (r) Guarded—protected with proper insulation. (s) Exposed—wire that may be dangerous in itself or it may be one that wasn't properly safe guarded from other wires. (t) Isolated—embodied in the wire as a safe protection. (u) Insulated—the protection required to be put in a building before the insolated wire is put through joists or other places. (v) Cutout—stop current. (w) Circuit—district. (x) Cutout—discontinue. (y) Conductor—by way of conduction.

Question.—What kind of fire protection should be installed in the vicinity of switchboards, generators, motors and other electrical appliances?

Answers.—(a) Conduit and like or similar insulation. (b) Automatic fire distinguisher. (c) Place switchboard in iron box. (d) It should be of a material that is a non-conductor of electrical current and also fireproof. (e) Porcelain is usually used in switchboards, etc. (f) Fire protection installed in vicinity of switchboards should be eather or boath non-current carrying and fire recisting.

Question.—What different non-current-carrying parts should be grounded?

Answers.—(a) Metal parts. (b) When possible where electrical apparatice is installed wires should be grounded frequently preventing short circuit. (c) At terminals. (d) While not altogether necessary all as much as possible. (e) All dead ends.

Question.—If oil-insulated transformers are installed inside of buildings, what are the requirements? What is the danger of this type of transformer?

Answers.—(a) Shaft ends should be protected with a cap or guard; pulleys, belts and other moving parts should be protected in the same manner. (b) Shafts should not extend beyond the hanger or covered with sheet iron guard. (c) Railing around pulleys and belts and danger warning where everybody could see it. (d) Are very susceptible to fire. (e) They should be installed in accordance with the State law as there is danger of fire from oils and waste.

Question.—How should switchboards carrying high tension be protected and guarded?

Answers.—(a) With woven wire guards with not less than two inch mesh. (b) Usual insulation; conduit and asbestos; notice of danger; guard chains or equivalent. (c) By cut-out fuses placed in metal casing lined with porcelain or non-combustable meterial. (d) They should be protected by some non-conducting box or hood with wood or leather on cut-off handles. (e) Should be guarded by having an outside lightning arrester and well grounded.

Question.—Explain when, where and how lightning arresters should be installed?

Answers.—(a) Lightning arresters should be installed just inside a building where the circuit goes outside. (b) Should be placed at least 20 feet from where wires enter building and well grounded. (c) Should be installed gest before wires enter building. (d) Where a smaller wire is to be connected to a larger wire. (e) Lightning arresters should be installed between a circuit carrying power and machine to be used so fuses will be burned out and current grounded. (f) They should be on all short circuits and run to ground.

Question.—What are the safety requirements relative to the installation of trolley wires for cars, etc.?

Answers.—(a) Should be equipped with non-conductors. (b) Employees must before taking hold or coming in contact with current see that they are well protected by a good non-conductor such as wood or rubber. (c) They should be well protected and permanently grounded.

Question.—What is the hazard of a bad joint? Give rules for making joints correctly.

Answers.—(a) Dangerous to touch, should be well covered with electrician's tape. (b) Wires are liable to separate causing short circuit. (c) Bad joint not protected could cause a spark to jump from one wire to another. (d) Liable to cause combustion. (e) A bad joint may cause fire, short circuit the other wires. (f) Soldered joints well taped is permissable.

Question.—Give briefly the general rules for installation of an iron conduit system.

Answers.—(a) The entire circuit must have it except where fixtures answer the purpose. (b) Pipes should be put down before floor is laid, all connected up same as gas pipes. (c) This is always installed in shortest and most direct way with no square corners, with all openings well protected so there will be no trouble in putting in the regular wire, everything is bent so there can be no tention on the power wire. (d) All conduits must connect with encases cut-outs lined with non-combustable material. (e) The rules for installing of an iron conduit the wires are to run through tubes under ground or through building and the pipes wrapped with non-conducting material. (f) All joints should be securely made and water proof.

Limited Police Power for the Fireman.

By John J. McCarthy,

New York Fire Department.

(Member N. F. P. A.)

Courtesy of American City.

In the hands of a policeman a summons is ordinarily more productive of good than is the nightstick. While the latter is an absolute essential when dealing with the disorderly and wilfully criminal elements of a community, nevertheless its use in the line of every-day police duty is rare. The summons takes care of almost all unlawful acts committed by the average citizen—acts invariably attributable to simple carelessness.

Let the driver of a vehicle take the wrong side of a street; let a dog go unmuzzled; let a retailer of foodstuffs neglect to keep his implements, floors, counters and goods in a tidy condition, or let a person pile refuse on a public thoroughfare—the policeman will very sternly inform the offenders that a repetition of the offense will warrant the service of a summons, and those persons will forthwith exercise great care lest a recurrence of their acts be the means of enriching the municipality to the extent of a few dollars.

Knowing the value of such a means of protecting the welfare of a community, why not extend this power to the firemen who go from house to house in their respective company districts, seeking to minimize the fire hazard? These men frequently find conditions which are by far a more serious menace to life and property than are the ordinary violations found by the policeman patroling his post, conditions which, in many cases, need only the flame of a carelessly thrown match to add perhaps hundreds of names to the roll

of those who annually perish by fire, and untold thousands to the amount yearly consumed by flame. Yet, without the power of serving a summons in such necessary cases, the fireman's hands are bound by official red tape, and the unscrupulous, knowing this, treat lightly any orders he may give. This is one reason why the annual fire loss in this country exceeds that incurred by European nations in normal times.

On the other hand, give the fireman the power of summarily bringing to court persons who fail to remedy dangerous conditions, after being allowed a reasonable period in which to do so, and one can rest assured that a knowledge of the fireman's power, and the publicity given cases where that power would be exercised, would go far toward the reduction of our losses. No one, perhaps, is better qualified to speak on this subject than the ex-Chief of the New York Fire Department, Edward F. Croker, and in his work on "Fire Prevention" he says:

> " . . . The solution lies in giving the Fire Department some measure of police power, so that it can itself enforce the regulations which are proper to safeguard life and property. A case in point where this is especially necessary is in the matter of clearing out accumulations of rubbish. In many a tenement in the city of New York, for instance, the cellar is little better than a junk heap. Piles of refuse and rubbish make it a positive menace to the building and the lives of all within it. When the Fire Department discovers a conditon of this kind it should have the power not merely to report the violation . . . but to order the owner or the tenant to abate the nuisance forthwith or within twenty-four hours. If this order is not complied with, it should have the further power either of eviction or arrest, or of having the dangerous cellar cleared out at the expense of the responsible person."

The opinion of so eminent an authority needs no further comment. But no one will appreciate the truth of his statement better than the uniformed firemen, who are in daily contact with the nation's greatest fire hazard, carelessness!

The heads of fire departments and of fire prevention bureaus throughout the country could devote their energies and influence to no greater cause than to seek legislation which will give their uniformed inspectors the power of serving summonses in necessary cases.

Rice Mills.

By Fire Prevention Bureau of the Pacific

(Member N. F. P. A.)

The object of rice milling is to produce cleaned rice by removing the hulls, or chaff, and polishing the surface of the grain. Rice as it comes from the thresher is known as "paddy" or rough rice, the outside hulls of which constitute from 18 to 25 per cent of its weight. The main processes, in the order of their occurrence, together with a description of the principal machinery used, are as follows:

Paddy Storage and Handling: Paddy is usually received in ordinary grain bags and stored either in a separate warehouse or on different floors of the main mill, while in the bags. Sometimes it is stored in small bins, to which it is elevated by means of elevators similar to those found in flour mills and grain handling warehouses.

Cleaning: The first process is the cleaning of the paddy, which is simply a screening process to remove trash and foreign particles. Cleaning is done in a monitor separator, similar to a grain cleaner.

Hulling or Shelling: The next process is the removal of the chaff or hulls by means of rapidly revolving stones, known as shellers, through which the paddy is passed. These stones are set horizontally about ¼-inch apart, so that the chaff is broken off, but the rice itself is not. Hulls are separated from the rice in another monitor separator. After being shelled, it is known as "brown" rice.

Paddy Separators: About 94 per cent of the paddy is shelled in the first operation of the shellers. The remaining 6 per cent is separated from the shelled rice in a paddy separator, from which it is sent back to the shellers. The paddy separator is a flat, table-like machine, in which the paddy is shaken through zig-zag channels.

Hullers: The next process is the removal of the thin skin, or bran, which is done in a machine known as a "huller," outwardly resembling a large sausage machine. The huller consists of a short iron horizontal tube, within which is a revolving shaft with ribs, or corrugations. These ribs are adjusted so that the revolution of the shaft grinds the rice together and removes the bran. The latter is removed from the rice in a hexagonal reel, then sacked and sold as cattle feed.

Bran Drying: Bran is sometimes dried before being sacked, the drier sometimes consisting of a revolving steel drum heated by steam pipes, and sometimes of a steam-heated table.

Brushing or Polishing: Rice is discharged from the reel to a bin known as a "cooling floor," where it remains for a few hours. In this bin the rice stands long enough to reach a uniform temperature, which does not necessarily mean that the rice cools, the term "cooling floor" being somewhat misleading. From the cooling floor the rice goes through the brushing machine, where the polish (middling) is removed.

The brush, or polisher, is made up of a rapidly revolving wooden cylinder 2 or 3 feet in diameter, supported by a vertical shaft, upon which sheep skins or other soft leather has been nailed, and enclosed in a stationary cylinder of fine wire netting, close enough to the leather to allow the latter to brush against the netting as it revolves; the whole is enclosed in an outside cylinder, or box, of metal or wood.

Trumbull Machines: Rice is sometimes coated with talcum and glucose in what is known as a "trumbull" machine, which is a large wooden cylinder revolving horizontally, heated by steam coils. Here the rice is given a very high polish by its rolling over and over with talcum and glucose.

Grading System: The final process is passing the rice through what is known as the grading system, where it is graded according to size. The grading system usually consists of three machines, the first a rice grading reel, the second a screening shoe, and the third a series of indented cylinders. These machines separate the broken rice from the whole grain, and grade the latter according to size.

Rice Flour: The grinding of rice into flour is not regularly done in rice mills, although occasionally a small amount of grinding will be done, the process being similar to grinding wheat flour.

Special Hazards.

The hazards of a rice mill would appear to be somewhat like those of a flour mill, though less severe on account of the smaller amount of ground cereal handled. The cleaning separators offer the same hazards as those in a flour mill or grain elevator; separators should be connected to proper dust collectors. The elevators in which rice is raised to a higher floor are similar to those in a grain elevator and present the same hazard. There is the usual bearing hazard, which is important. The bran driers and trumbull machines use steam coils, but these should be of no particular danger if proper clearance is allowed.

Probably the most hazardous machine is the polisher, where a spark is sometimes struck by the friction of the leather on the wire. In a machine made entirely of metal, or nearly so, there is but very little chance of a fire getting out of it. A wooden polisher should always be protected with a live steam jet, or by automatic sprinklers, if the mill is equipped.

In sprinklered mills the reels, separators and elevator heads should also be protected with inside sprinklers.

The chaff, or hulls, from the shellers is a waste product, but is occasionally ground very fine and mixed with other ingredients to form a cattle food. It is ground in what is known as an attrition machine, which consists of two vertically revolving metal discs enclosed in a metal case. These machines revolve at a very high rate of speed and introduce an important bearing hazard and also a danger of striking sparks from metallic substances in the chaff.

Water Distribution Systems and Fire Protection.

By George W. Booth,

Chief Engineer Fire Prevention Committee, National Board of Fire Underwriters.

(Member N. F. P. A.)

The distribution system of a public water-works may be considered as made up, in addition to the street mains, of valves, fire hydrants, service connections and fixtures, including those which furnish supply to sprinkler equipments and standpipes.

In designing a new system, it is necessary to decide upon the use of one of the many formulas which have been devised to determine the probable carrying capacity of different-sized mains. It has been our experience that the Williams & Hazen formula, used either in connection with the book of tables or the slide rule, is the most generally convenient. The values of "C" in this formula, as given in the tables, apply very well to pipe carrying impounded surface water; these values show a decrease in carrying capacity of cast iron of 25 to 30 per cent in twenty years, and of 38 to 45 per cent in forty years. The smaller sizes naturally show the greatest decrease. For most well waters and the harder waters found in the Great Lakes, the rate of deterioration is somewhat less, and a higher value of "C" must be used for pipe of a given age.

Mains for Hydrant Supply.

No pipe as small as 4-inch should be laid to supply hydrants; roughly, one 6-inch will carry the same quantity of water as three 4-inch, and one 8-inch the same quantity as six 4-inch. The recommendations as to sizes of minor distributors incorporated in most of the reports of the Committee on Fire Prevention of the National Board of Fire Underwriters read as follows:

"That the following be adopted as the standard minimum size of mains used for hydrant supply for all future construction:

"(a) In residential districts, 8-inch; 6-inch to be used only to complete a good gridiron, and in no case in blocks 600 feet or more in length.

"(b) For important mercantile and manufacturing districts, 8- and 12-inch; the former to be used only in sections where they complete a good gridiron and the latter for long lines not cross-connected."

The further recommendation is usually made:

"That all 4-inch mains used for hydrant supply be replaced within five years."

A note attached to this recommendation reads:

"A gridiron system of mains of the sizes recommended above is satisfactory only when cross-connected at all intersections, free from dead ends, and with large secondary cross-feeder mains at frequent intervals."

The maximum allowable length of the smaller mains between supporting larger mains is dependent very largely upon the spacing of the 12- and 16-inch secondary feeders, and somewhat upon the initial pressure available. The maximum of 600 feet for a 6-inch pipe is intended to apply to the type of system most often found, with 12- or 16-inch mains 3,000 or 4,000 feet apart in either direction, and carrying such pressures that the total friction loss in the distribution system should not be allowed to exceed 15 or 20 pounds during maximum draft. There are some systems having secondary feeders not more than 1,500 or 2,000 feet apart, or with an unusually high initial pressure, where an unsupported length of 1,000 or 1,500 feet of 6-inch pipe will still be able to furnish adequate hydrant supply at pressure not too greatly reduced.

For pipe extensions into newly developed districts, where the gridiron, as well as the supporting system of large mains, is likely to be incomplete for some time, a number of progressive departments are using 8-inch as the minimum size. Other cities have in years past adopted the contrary policy of laying 4-inch mains into new sections, on the theory that the demand would be light and no larger size was justified, and with the result that as these sections became more closely built it was difficult to secure an adequate system without replacing the smaller sizes. However, it is at present the almost universal practice to lay no pipe smaller than 6-inch for hydrant supply. A recent summary of the practice in twenty-five cities in New England and New York shows only one where 4-inch is still being used; in most of them the 4-inch is gradually being replaced, and in a few others there is none in service.

Distribution Mains.

For mains in the distribution system, cast iron is usually considered in a class by itself, both as to length of service and general reliability. It is, however, subject to occasional sudden and disastrous breaks, sometimes without apparent cause. Care is necessary in testing for defective pipes, both at the foundry and after laying, and many ruptures have occurred from a settling of the pipe line or from lack of care in avoiding high points of rock or hard earth in the trench, resulting in an uneven bed and unusual stresses in the pipe. In the attempt to find a material less liable to sudden rupture, the use of steel or wrought-iron pipe has been advocated. For the separate fire main system in the city of Baltimore, installed in 1910, steel pipe was used, with special attention to eliminating impurities from the metal and securing an effective and durable coating for the pipe. Both these points are essential if corrosion is to be avoided. Kalamein pipe, which is essentially a galvanized pipe, has been used with considerable success in some Western cities; it has not the life of cast iron, but it is not so liable to rupture. Woodstave pipe has also been tried in some Western cities. and banded wooden pipe in some Eastern cities, but their use in distribution systems is not advocated by the water-works officials who have had experience with it.

About twenty or thirty years ago many systems in the East, especially in New England, were constructed of cement-lined pipe, which consists of a thin sheet of wrought-iron or steel, covered with cement mortar inside and out, and in some cases of two wrought-iron shells, with layers of cement between and outside of them. These pipes sometimes gave good satisfaction for a number of years, depending largely upon the quality of workmanship. In general, this class of pipe has been found unreliable and subject to more or less frequent breaks, usually because the cement lining was not water-tight and the wrought-iron has corroded and become so weakened that a slight shock has ruptured it. Trouble has also resulted from lightning discharges, which have, in some cases, ruptured a considerable length of pipe.

Gate Valves.

From a fire protection standpoint, the main consideration in respect to gate valves is to secure sufficiently good spacing so that it will not be necessary to close off an unreasonable length of pipe in case of accident or repairs. The recommendation in the National Board reports that this length of pipe shall not exceed 500 feet in mercantile or manufacturing districts, nor 800 feet in other districts, is considered reasonable, since many of the systems reported upon have gate valve distribution at least as good as this. A properly designed and ruggedly constructed valve is, of course, essential to good maintenance and reliable service.

To make sure that valves are in good condition and are left open after being used, systematic inspections should be made at least annually, and records kept of inspections and of all valves operated. A good illustration of the necessity for this is offered by the results of an inspection by the water department of a certain large city a few years ago: of about 7,000 valves inspected, 49 were found closed, 300 partially closed, and 100 were either not shown on the plans or were not in the ground. In another case a serious shortage of water at a rapidly spreading fire was discovered to be due to a closed gate. In some cities care has not been taken to secure gates all opening in the same direction, with the result, especially when no proper records are kept, that gates supposed to be opened have been closed.

In one city of about 30,000 population the fire flow tests conducted by National Board engineers showed a drop in pressure much greater than was anticipated. There were two mains, a 16-inch and a 12-inch, extending from the pumping station to the mercantile district near by, with connecting lines crossing the street between the two mains; there should have been an adequate quantity of water available, with a loss of head of 15 or 20 pounds, whereas a less discharge resulted in a loss of head of over 80 pounds. It turned out that a valve on the 16-inch line and two on the connecting lines were closed, although supposed by the water department to be open; they operated in the opposite direction to most of the others in the system and had been closed for no one knows how long, with little likelihood of the fact being discovered except by some such tests as were made.

Hydrants and Hydrant Spacing.

Hydrants should be of such dimensions and design as to pass adequate quantities of water with reasonable loss of head, should be sufficiently well distributed to permit of the maximum number of streams required to be concentrated on any fire without hose lines of excessive length, and good condition should be assured by frequent inspection and repairs when necessary.

Comparatively few fire departments attempt to supply more than one engine, serving an average of two hose lines, at a hydrant, or to use more than two direct hose lines from each hydrant. For this service, which means a flow of 500 or 600 gallons per minute, the use of a hydrant with 5-inch foot-valve and 6-inch barrel and branch will result in a total friction loss of not more than 3 pounds, and this figure may be taken as a reasonable maximum loss under maximum draft from any hydrant. Smaller dimensions than those noted above may be allowable for hydrants on small systems or in scattered residential districts, but in general no 4-inch hydrants nor connections to mains should be used, and it is often worth while to replace 4-inch connections, especially if more than 10 or 12 feet long.

A study of hydrant spacing in most of the large cities of the country has led to the conclusion that the area served per hydrant is a better index of the protection afforded than is the linear spacing or distance between hydrants. This is so mainly because of the difference in the size and shape of blocks in various cities. An area divided into large blocks will require fewer hydrants to secure a given linear spacing than if the same area is divided into small blocks, even though in the former case the fire hazard and the necessity for good hydrant distribution are greater.

The quantity of water required for any district having been fixed upon, proper hydrant distribution may be best determined from a sketch plan of such a number of hose lines as are necessary to care for this quantity. A consideration of friction losses in hose indicates that for anything like effective service no hose line should exceed 600 feet in length if from a fire engine, nor 500 feet if direct from a hydrant, unless the hydrant pressure considerably exceeds that usually found where direct hydrant streams are depended upon. Considering the number of streams usually taken from any hydrant, most high-value mercantile and manufacturing districts will require at least one hydrant to each 40,000 to 80,000 square feet of area, and ordinarily well built-up residential districts one hydrant to each 100,000 or 120,000 square feet. The requirements will vary between the limits named, depending upon the total amount of water needed, and upon whether direct hydrant streams or fire engine streams are used. As good or better distribution will be found in many of our larger cities, and in the case of mercantile districts such distribution corresponds roughly to a linear spacing of 150 feet and in residential districts of 300 feet. For each mercantile block 400 by 300 feet, center to center of streets, there should be at least three hydrants, probably located to the best advantage two at each street intersection and one intermediate hydrant on the long side of the block.

Hydrants in poor condition are most often the result of indiscriminate use for other than fire department purposes. This results in worn operating nuts, worn and battered threads and leaky foot-valves. This latter trouble is probably responsible for most frozen hydrants, since a hydrant with a tight foot-valve and proper drainage will seldom be found frozen.

Quantity of Water Required for Fire Protection.

Reasonable fire protection requirements will vary with structural conditions and with other features affecting the conflagration hazard, and to some extent with the fire department strength of the city under consideration and of its neighbors. Population is naturally not always a fair guide, but on the whole appears to be the best measure for the approximate quantity of water necessary. Reports issued by the National Board recommend a minimum of 1,500 gallons per minute in residential districts, and for high-value districts a quantity approximately equal to $1{,}000\sqrt{x}$ where x is the population in thousands.

These quantities are considered to be perhaps 50 per cent in excess of what may actually be used through hose lines. The 50 per cent allowance is intended to take care of the loss through broken service connections to buildings burned during the early stages of a bad fire, and will enable normal pressure conditions to be maintained for a time at least, so that the fire department may not be hampered by lack of pressure as long as there is a chance to control what might develop into a conflagration. During most of the conflagrations in which an estimate of the amount of water used has been possible, the maximum used on the fire and wasted through broken services and hydrants left open has been far in excess of what any of these systems may reasonably be expected to deliver while still maintaining normal pressures. At Salem, for instance, the maximum was at the rate of nearly 18,000 gallons per minute, nearly three times the amount called for by the above requirements. This quantity was, of course, delivered at very low pressure, and was only possible because of the emergency connections to the systems of adjoining municipalities.

To determine the pipe sizes necessary in designing a new system, analytical methods must be used, with certain assumptions as to the effects of tuberculation of mains and other friction-producing elements. The same method may be used in determining the capacity of an existing system, but the results will be at best very approximate and actual flow tests from hydrants will give much more satisfactory and reliable figures.

The method of conducting such tests as practiced by the engineers of the National Board of Fire Underwriters is a development of the scheme of measuring discharges from smooth-bore fire department nozzles by means of the Pitot tube and gage, originated by Mr. John R. Freeman and now used by the National Board in its tests of fire engines.

Measuring Hydrant Discharges.

It is possible to measure hydrant discharges with much greater accuracy by the use of short lines of hose and large nozzles than from

open butts. However, in cities where the normal hydrant pressures are low, only a small part of the total quantity available for engine supply may be obtained in this way, and much more time and labor is consumed than when open butt discharges are measured. For these reasons, and in order that a representative number of tests might be made in a reasonable time in the various cities reported on by the National Board, the present scheme was worked out. It is believed that the results obtained will show not more than 5 per cent of error.

The number of hydrants in a group, all of which are opened simultaneously, varies from 3 to 6, or even more in exceptional cases, depending upon the quantity of water available, the pressures and the character of the district in which the test is made. It is usual to open all available outlets on the hydrants used. However, if the pressures are high enough to furnish effective streams direct from hydrants, it is better to open only enough outlets to lower the pressure in the mains to a figure assumed to be the minimum consistent with good fire service, which will range from 60 to 75 pounds or more, depending upon the character of the district.

The pressure in the mains before and during the tests is determined by attaching a gage to a hydrant preferably located near the center of the group to be tested. It is sometimes advisable to have another gage at a hydrant outside the group, to determine the loss of head in the main arteries, or a recording gage located near the center of the distribution system may serve the purpose for a number of groups. Knowing the loss of head due to ordinary consumption, and the additional loss due to the measured flow from hydrants, a close approximation may be made of the quantity available at any given pressure.

Hydrant outlets, especially the large ones, are often not completely filled by the stream; the area of no flow is almost always a segment in the bottom of the outlet, of varying height, depending upon the design of the hydrant and somewhat upon the velocity of the stream. Any projection into the waterway, such as the end of the stem of an independent valve or a roughness of the nipple, will also produce small "holes" in the stream. The area of no flow is in most cases fairly well defined, and the shape of the "hole" is sufficiently uniform to enable its proportion to the total area to be determined by measuring its height with a rule. For instance, with 4½-inch outlets, a "hole" 1 inch high forms 10 to 12 per cent of the area of the outlet; a 1½-inch hole 20 to 25 per cent, and so on.

In determining the average velocity of the stream issuing from the outlet, the Pitot tube is moved throughout the area, and the observer will soon train himself by this traverse to fix upon a substantially accurate average. Readings noted at the center and near the ends of the horizontal and vertical diameters will usually suffice, and the center reading in a small outlet is in most cases very near the average for the whole area. Readings should not be taken closer than one-fourth inch to the sides of the orifice, since there is a noticeable retardation of velocity caused by friction against the walls of the hydrant nipple. This retardation necessitates applying a co-efficient of discharge, which has been determined by careful experiments to be about 0.90; this is to be applied

after allowance has been made, as above noted, in the case of outlets not completely filled by the stream.

The Pitot tube used in determining discharges from hydrant outlets has a straight blade about 4 inches long, which is threaded into one end of a piece of ¼-inch brass pipe 8 or 10 inches long, on the other end of which is screwed the gage by which the velocity of discharge is determined. The gage which appears to be best suited for this work is 3-inch, graduated in half-pounds, from 0 to 50 pounds. Such a gage may be read easily to the nearest quarter pounds; corrections should be made as indicated by calibrations before and after using, either by means of a weight tester or by comparison with an accurate test gage.

Fire flow tests made as described above have been made by National Board engineers in more than 250 cities throughout the country. This method has also been adopted by a number of water departments and private companies. It has proved to be very useful in determining the quantities of water available for fire protection and the sizes of mains necessary for proper reinforcement, as well as to detect abnormal conditions, such as closed valves or other obstructions in the mains. It is believed to be the easiest and most reliable method of making the determination which may be considered final in any system—i. e., its ability to deliver water at the hydrant outlet.

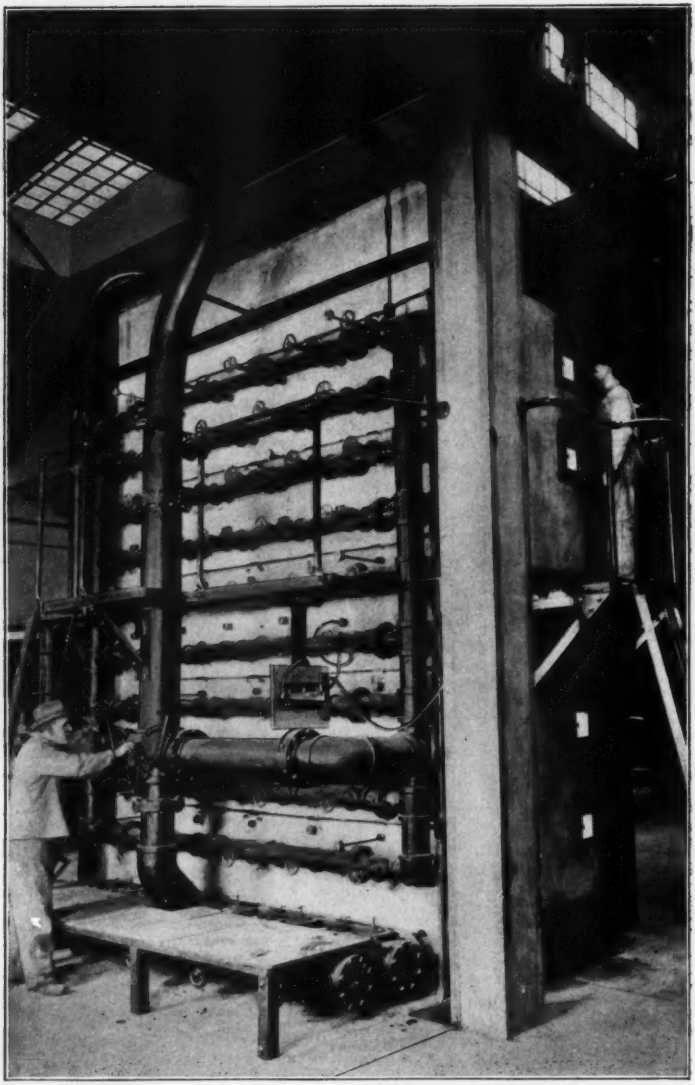


Fig. 1. Panel Testing Furnace. View of rear and end of furnace showing piping, control valves, observation gallery, pressure gauges and furnace thermo-couples.

Fire Tests of Doors and Windows at Underwriters' Laboratories.

By M. L. Carr,

Division Engineer, Underwriters' Laboratories.

(Member N. F. P. A.)

Fire tests of doors and windows at Underwriters' Laboratories are made by exposing one side, usually the side away from the wall in the case of doors and the weather side in the case of windows, to the action of fire in order to determine their flammability, their values as barriers to flames and heat and their stability under fire conditions.

Apparatus and Methods:

The tests are made in a furnace designed especially for testing walls, partitions and devices intended for the protection of window and door openings, the appearance of which is shown by Figs. 1 and 2. It has been described at length in a previous issue and readers who desire information regarding details of construction are referred to Vol. 9, No. 3, of the *Quarterly*. Briefly described, it consists of a brick combustion chamber, one side of which is closed by a movable wall in which the sample to be tested is installed as it would be in actual practice. The movable wall is of such size as to provide for a door or window opening about 11 feet wide by 13 feet high, maximum dimensions for the reception of test samples. The size of the opening available depends to some extent upon the degree of restraint required against expansion of the test specimen and upon the nature of the construction required by the device at the edges of the wall opening.

The furnace is heated by large burners fed from city gas mains and supplied with air from a motor-driven blower, suitable valves being provided for regulating the intensity and distribution of the fire. The temperature of the fire is measured with thermo-couples at a number of points distributed over the face of the test sample and about six inches therefrom, fifteen couples being employed in connection with the largest doors or windows.

The temperature of the air on the side opposite the fire is measured at a point in contact with the sample and at points 32, 64, 96 and 128 inches from its center in all tests, and in some tests at points approximately 20 and 30 feet distant. Cloth strips located 32, 64, 96 and 128 inches away are also used to indicate roughly the amount of heat given off.

Standard Fire Tests:

The Laboratories' standard test for a fire door or window is of one hour duration with the average furnace temperatures regulated

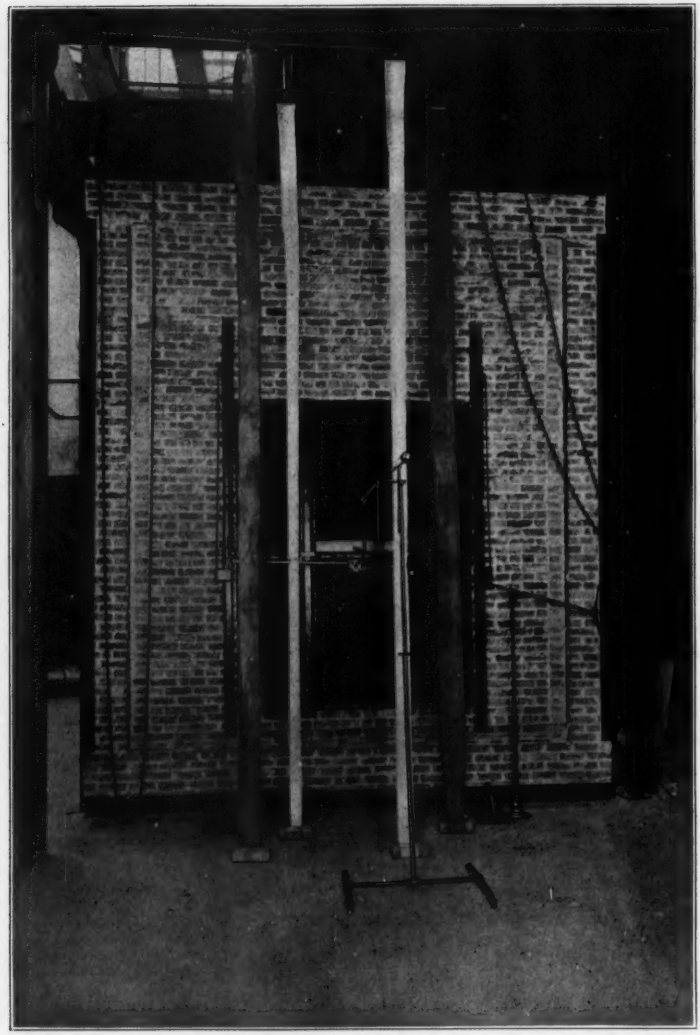


Fig. 2. Panel Testing Furnace. Counter-balanced elevator door installed in panel preparatory to test, with typical arrangement of cloth strips, thermocouples and thermometers for indicating amount of heat transmitted and radiated during test.

Fig. 3. Tin-Clad Door. Fire side of 2½-inch 3-ply door after exposure to standard fire test conditions for one hour. A fire stream was not applied to this test sample.

so as to conform as nearly as possible to a standard time-temperature curve which provides for a temperature of 1,550 degrees Fahr. 30 minutes after the starting of the test and for 1,700 degrees Fahr. 60 minutes thereafter.

At the end of the fire test the sample is usually subjected to the action of a ⅞-inch fire stream applied from a distance of 20 feet at a pressure of 60 pounds for a length of time determined on the basis of one minute for a 5 by 7-foot sample.

In response to a growing demand for larger fire doors on account of the needs of modern business conditions and to the increasing insistence of health and other authorities upon better provisions for

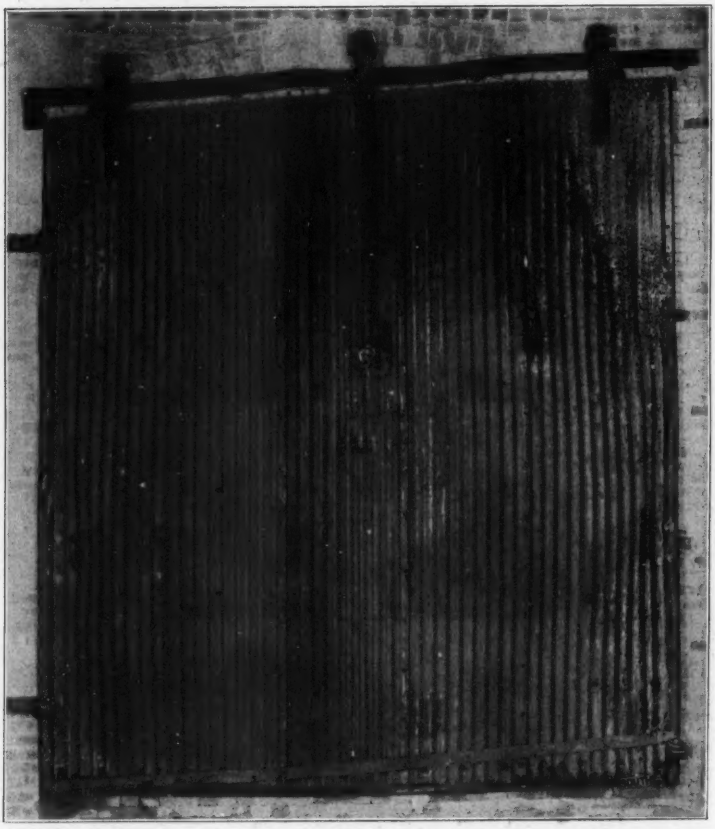


Fig. 4. Sheet Metal Fire Door. Fire side of sheet metal door after exposure to standard fire test conditions for one hour and to standard fire stream test for two minutes.

light and ventilation, a considerable number of devices designed to meet such requirements and at the same time to provide for the requirements of fire protection have been tested within the past year. Among the more interesting are: a test of a large tin-clad door, a test of a large sheet metal fire door, and tests of several large fire windows. In general it can be said that all of the tests here briefly described yielded better results than were anticipated.

Tin-Clad Fire Door.

A 2½-inch standard tin-clad sliding fire door for a wall opening 10 feet wide by 12 feet high was tested with results not materially different from those noted in other tests of similar doors for openings

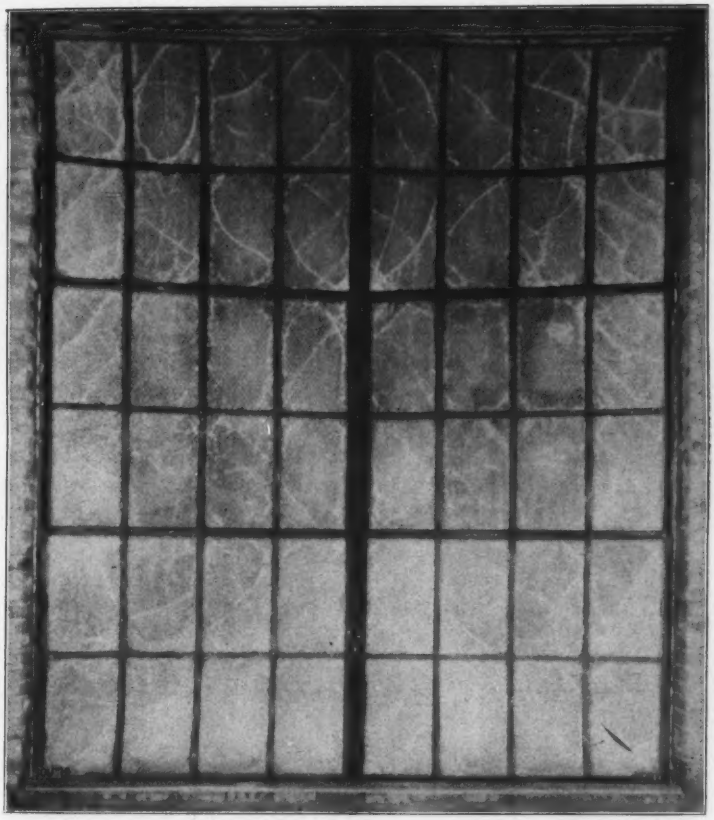


Fig. 5. Solid Section Fire Window. After exposure to fire for one hour with furnace temperatures rising gradually to 1700° F. and to standard fire stream test. The wall opening was 10 feet wide by 12 feet high.

5 feet wide by 8 feet high. The test showed that it is advisable to provide additional vents and chafing strips in order to reduce bulging of the tin covering, and for at least three binders. The appearance of the door after the test may be seen by reference to Fig. 3.

Sheet Metal Fire Doors.

One test of a sheet metal fire door for an opening 10 feet wide by 11 feet high has been made with results similar to those obtained in tests of smaller doors of the same kind, but, owing to the fact that official action with respect to reporting upon and listing it has not been taken, it is not permissible to publish details at the present time. Another test to be made soon is of two sheet metal fire doors

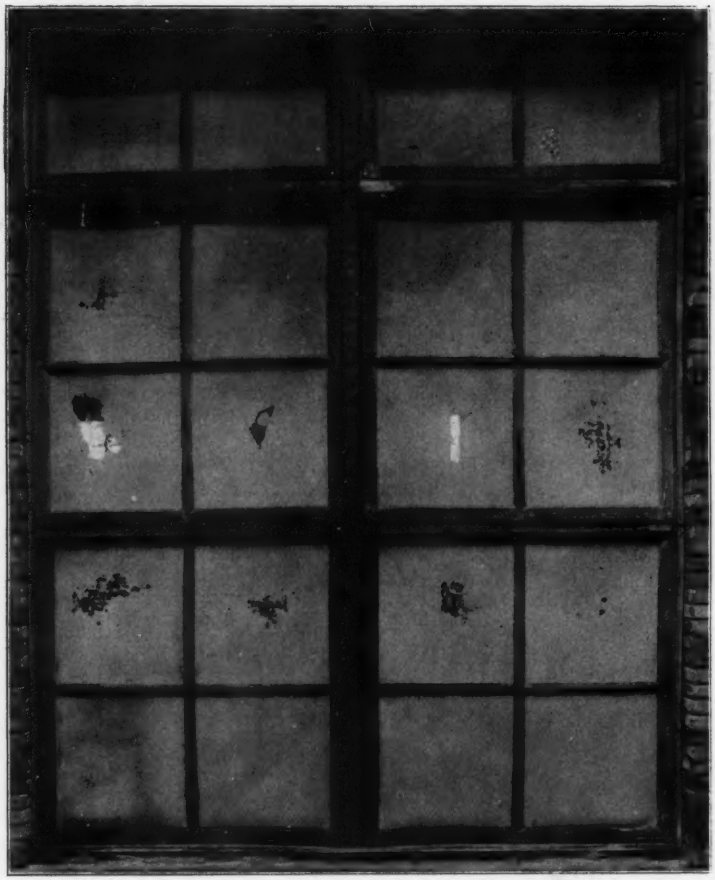


Fig. 6. Hollow Metal Fire Window. After exposure to fire for one hour with furnace temperatures rising gradually to 1700° F. and to standard fire stream test.

installed with one door on each side of the wall opening. Each door is to be provided with a wicket door designed to comply with certain State requirements regarding exit facilities. The appearance of the sheet metal door tested is shown by Fig. 4.

Windows.

Up to the present time several tests have been made upon wired glass windows of the solid section pattern, Fig. 5, in sizes ranging from 9 to 10 feet in width by 9 to 12 feet in height. Each window

consisted of two window units with a non-load-bearing steel mullion between them.

One test has been made upon a wired glass window of the hollow metal pattern for a wall opening 10 feet wide by 12 feet high, Fig. 6. The window consisted of two window units each approximately 5 feet wide by 12 feet high with a non-bearing steel sheet metal mullion between them.

In general it can be said that the tests have shown that properly constructed wired glass windows of large size of either pattern are equally as efficient as smaller 5 by 7-foot windows tested heretofore as barriers to flame, but that owing to the larger areas involved, the amount of heat transmitted will be greater for similar conditions of fire exposure.

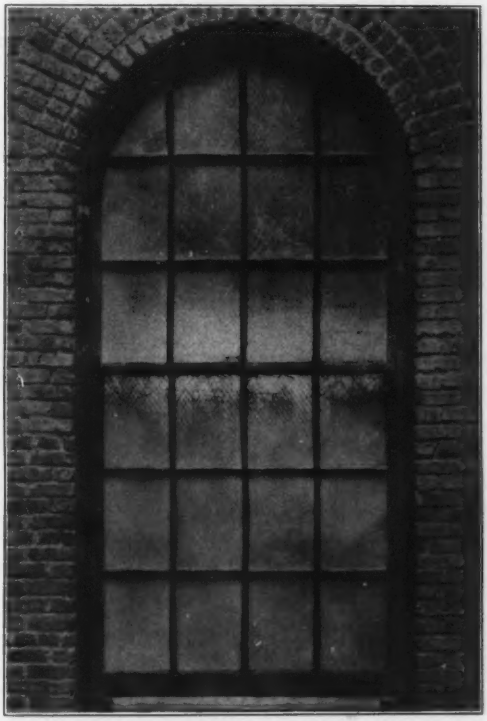


Fig. 7. Experimental Sample. Wired glass window with 12 by 17-inch lights after exposure to fire for one hour with furnace temperatures rising gradually to 1700° F. and to standard fire stream test.

Developments in Fire Windows:

While very little of the details may be given out at the present time, it can be said that considerable progress has been made along two lines in the further development of fire windows. This work is being prosecuted at the Laboratories for The National Association of Manufacturers of Hollow Metal Windows.

One of the lines mentioned is a window with smaller lights and narrower muntins, the sizes of the lights being properly proportioned to depths of the grooves retaining them. Up to the present time practically all hollow metal windows have been provided with grooves ¾-inch deep. While ¾-inch depth of groove makes permissible lights of 720 square inches area, there are many situations where for architectural reasons smaller lights and narrower muntins are desired. One test has been made recently of a window of this kind with good results considered from a fire protection viewpoint, as may be seen by Fig. 7.

The other type of window undergoing development is designed for use in situations subject to light fire exposure, such as across wide streets, or from other windows in the same building. The end sought is to produce a non-combustible window of sufficient fire retardant value for such uses, in which it will be permissible to employ lights of wired glass exceeding 720 square inches in area. The Association hopes to be able to produce a window that will have all of the desirable features of wooden windows without the objectionable ones of being ignitible by radiant heat or by flames issuing from other windows in the same building. The progress of the work to date has been encouraging. Fig. 8 shows a window that was subjected to fire for one hour, the furnace temperatures being increased gradually to 1,200 degrees Fahr. (instead of to 1,700 degrees Fahr., as in tests of windows for more severe exposures) by the end of the test period. It was subjected to the standard fire stream tests for one minute immediately following the fire test. The holes in the central portions of the lights were produced by the impact of the stream.

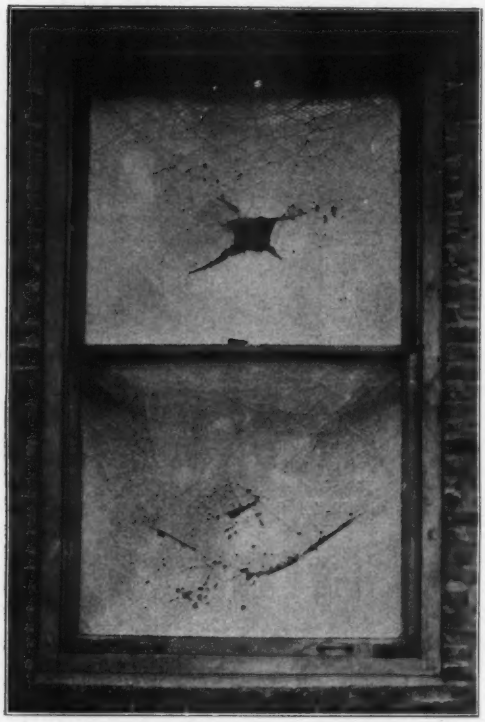


Fig. 8. Experimental Sample. Wired glass window with 43 by 51-inch lights after exposure to fire for one hour with furnace temperatures rising slowly to 1200° F. and to standard fire stream test.

It is estimated that about five hundred tests of fire doors and windows of all types and patterns have been made at Underwriters' Laboratories. The great majority of these tests were made at the request of individual manufacturers, but recently, co-operative testing has been coming into favor—the manufacturers in an industry with common problems joining in the conduct of a relatively few tests of representative constructions so designed as to develop principles of design rather than the merit of particular devices. This method of procedure possesses the advantages of making for a better

understanding on the part of the Laboratories and of the manufacturers, of each other's problems, and for a more efficient co-operation as well as a saving in time and expense.

Fire Hazards in Rubber Mills.

From the India Rubber World.

In the matter of fire hazards, every industry has its own individual peculiarities. The manufacture of rubber goods is no exception. Besides the possibilities which are common to any and every manufacturing establishment of similar build and of equal size this industry is subject to some special risks, and therefore the study of the causes of fires is an important one, and the better known they are, the more satisfactorily can they be guarded against, or more quickly extinguished when they occur.

Very thorough and exhaustive researches have been made by insurance adjusters, as well as by chemical experts, as to the principal causes of fires in rubber factories. The result of these studies seems to show that outside of those causes common to all factories, the principal dangers peculiar to rubber manufacture come from the inflammability of the solvents used in the industry, from spontaneous combustion of some of the materials, and from excessive heat in some of the operations. The two latter, however, are but minor hazards; practically the all-important one is in the use and storage of naphtha and similar solvents, and the preparations into which these enter.

A careful and comprehensive study of all the processes in the manufacture of rubber, made by Charles E. Macomber, Jr., of the National Fire Protection Association, has led him to the following conclusions:*

There is no fire hazard in crude rubber, nor in the process of washing. In drying, he recommends that if the ordinary system of steam coils is used, care should be taken that the pipes are properly installed, resting on iron, bushed where they pass through wooden partitions or floors, and protected by screens, so there will be no danger of stock coming in contact with them. Should a system be in use requiring a fan, additional precautions should be taken.

In the vacuum system of drying there would seem to be no more hazard than there would be in the installation of a steam pump or similar piece of apparatus.

In the mixing rooms there is no material hazard, as the temperatures of the material in process of compounding cannot be carried high, on account of the possibility of spoiling from this cause.

The storage of the various ingredients may constitute a hazard, however. As a rule these materials are stored in the compounding room only in sufficient amounts for immediate use, the bulk being kept in original packages, which are stored in a warehouse or portion of the factory reserved for that purpose. Among the materials which

* See Quarterly, Vol. 8, No. 1.

may cause trouble, this investigator mentions lampblack, which, he says, should be kept dry and stored in small quantities, preferably in metal containers with tightly fitting metal covers, for there are cases when, under certain conditions, it has been known to heat and ignite spontaneously.

While sulphur is always found, it in itself presents no special hazard, except that its presence would add fuel with the evolution of objectionable gases. There are also stored various oils, resins, waxes and the like, but with proper care these should give no trouble. In fact, this is true of all the material used in the compounding of rubber. He considers that there are no special hazards in calendering, frictioning or impregnating, as the degree of heat is low, owing to the danger of spoiling the compound.

In the making, however, comes the hazard of the use of rubber cement, and to this one preparation is laid the blame for the vast majority of fires in rubber mills. The hazard both of the manufacture and use of this article is due to the solvent used to get the rubber in solution. This is naphtha. The kind generally used and most preferred is that having a specific gravity of .706, 70 degrees Baumé, boiling at 180 degrees F. and flashing and burning at ordinary temperature.

It is recommended that the manufacture of cement should always be conducted in a detached building away from the main plant, well ventilated and carried on without the aid of artificial light. If light be necessary, incandescent light should be used, the sockets to be keyless, the wiring run in conduit, the lamps enclosed in vaporproof globes, and the switches and fuses located outside of the building. The naphtha should be stored in an underground tank located 30 feet or more distant from any building, and pumped as needed to the cement mixing room.

Power for churns (these are best of the enclosed type) should be furnished from outside by means of shaft or some kind of a drive permitting a cut-off opening. While the speed of the churns is necessarily slow (owing to the ease with which rubber is electrified by friction and pressure), as a precautionary measure it would seem advisable to "ground" all of the machinery.

The cement, except that in immediate use, should be stored in tightly covered metal cans. There are cans on the market designed for this purpose.

If the plant be sprinklered the cement house should contain a standard system of automatic sprinklers, and in all cases the cement room should be provided with a steam jet of ample size for smothering fire, having an easily accessible valve located on the outside of the building.

A day's supply only should be brought into the factory, and only enough distributed to the operators for immediate use. At the close of the day that remaining in the small pans should be returned to the container, which should be removed to the cement house.

In some factories naphtha is used for thinning the cement at the benches. This would seem to present a needless hazard, for the

cement is easily made of the proper consistency, and if used in small quantities at a time there should be very little evaporation and thus no call for the addition of naphtha.

Lighting here should be incandescent electric. The making room should have at least half of its fire pails filled with sand and supplied with a scoop for using it, as cement fires are best put out by smothering.

Some of the hazards above mentioned are also applicable to varnish. Some factories manufacture their own varnish. This should always be made in a well-detached building. The building used for the manufacture of cement could be made large and a section of this building could be used, cut off by parapet fire walls, with no openings into the cement section. The varnish is made from linseed oil, which is bought, generally, in the raw state and boiled here.

It is the opinion of this investigator that this section should be made thoroughly fireproof, and that sprinklers might be omitted. Floor should be concrete and fitted with a drain leading to a blind pit of ample capacity, located 50 feet or more from any building.

The vessels in which the oil is boiled should be sufficiently large, so that the oil can in no way boil over. Coke or hard coal, it is believed, is best for fuel. Gas is sometimes used, but might cause danger, owing to drafts.

Varnish also contains rosin or some cheap varnish gum; also sulphur in small amounts.

After the varnish is boiled for a proper length of time it is thinned down with naphtha. This hazard is similar to the cement hazard, and the naphtha should receive the same treatment here.

Varnish should be stored in strong metal tanks, and pumped out as needed. It is often brought to the factory in pails. The best way would seem to be a system by which it can be pumped to the place where it is used. The investigator has seen an installation where the pump is controlled by an electric device in the varnish room, arranged so that the pump can be started up or shut down at will. The piping is arranged to pitch back to the pump, so all varnish drains back to storage tank when pump is stopped. The amount of varnish in the factory should be limited to a day's supply.

Lighting in this department should be incandescent electric. Varnish room should be well ventilated and cut off from the main plant and vulcanizer room. Dip tanks, if used, should be installed to conform, where practicable, to the rules and requirements of the National Fire Protection Association.

Dry heaters for vulcanizing should be located in a well cut-off section. The tin lining should be standard, and attention should be given steam pipes to prevent contact with all inflammable material. They should be provided with a steam jet having an easily accessible valve, so they could be flooded with steam if necessary.

They should also be protected by a standard system of automatic sprinklers, although the manufacturers, almost without ex-

ception, take issue to this, owing to the fear of premature opening of the sprinklers, as the presence of water during the vulcanization process would ruin the goods.

The foregoing hazards, or some of them, and the precautions recommended apply practically to all rubber factories. But besides these are others applicable to the manufacture of rubber-coated fabrics. Our readers are familiar with the operation of the spreading machines, and know of the danger of ignition of the naphtha fumes from sparks of static electricity, which is generated in the fabric by friction and pressure. This, according to another investigator, has been found to be very largely a matter of humidity, which will be referred to later.

The dough or spreading mixture is simply compounded rubber which by means of naphtha and churning has been made of a dough or cement-like consistency. The hazard of manufacture of this material should be safeguarded in the same manner as described for the manufacture of cement.

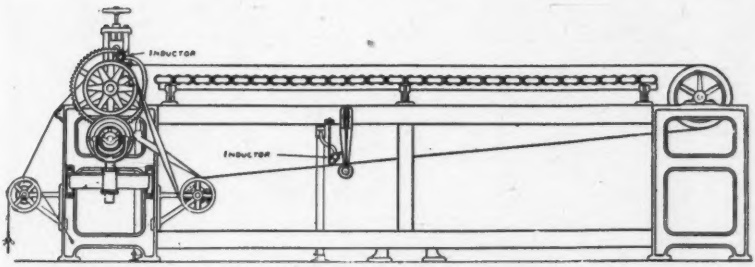
Spreading machines should be located in a detached or well cut-off section of the plant. The hazard of the operation is entirely due to the presence of the naphtha used in the spreading compound. Rubber being easily electrified by friction and pressure, and as it is thought by some engineers that the evaporation of naphtha also causes this phenomenon, the spreading machine should be equipped with devices for removing these static charges.

The methods in use for guarding this hazard are as follows: All metal and moving parts of the machine are well grounded. Directly in front of the knife is located a steam jet. Bearing on the under side of the fabric is a wire which collects any charge which is not broken up by the steam jet.

In some factories the speed machines are equipped with an electric device known as the Chapman Electric Neutralizer, which distributes alternating charges at high voltages in minute quantities to the places where the static charges collect. This works on the principle of the simple law of attraction and repulsion, that the static charge in any insulating material selects for itself the kind and quantity to exactly neutralize itself.

In the application of the Chapman neutralizer to spreading machines, the transformer is located on some convenient wall and a single heavily insulated wire leads to the several machines to be treated. Each spreading machine is fitted with two "inductors" extending across the machine over the fabric. One is placed just back of the spreading knife and the other near where the fabric is rolled up. The positions of these inductors are shown on page 75.

These inductors are placed so that the fabric passes them at a distance of from two to four inches. The influence of the inductors extends through the air for several inches around them, and every portion of the fabric as fast as it comes within this region of influence is imperceptibly but instantly deprived of any electric charge existing upon it.



The Chapman Neutralizer.

The result of this action is that the inductor at the head end of the spreader instantly and completely neutralizes every part of the fabric as fast as it leaves the spreading knife, before any charge imparted to the fabric can accumulate sufficiently to discharge to the roll, knife, frame or pipes in the form of a spark.

The object of the other inductor, treating the fabric just before it is rolled up, is to remove any slight charge redeveloped by the other rolls over which the fabric passes before winding up.

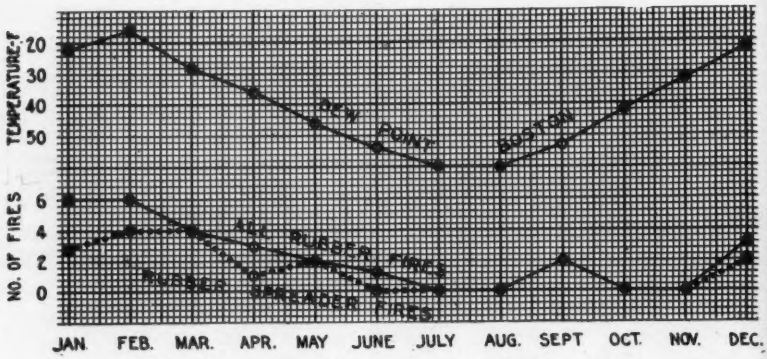
According to investigation made by the Inspection Department of the Associated Factory Mutual Fire Insurance Companies, it has been concluded that if the humidity of the room where the spreading machine is conducted is kept at about forty-five per cent., there will be little danger of fire from this cause.

As a proof that the chief hazard in rubber factories is due to ignition of the spreading material through sparks of static electricity, F. J. Hoxie, a well-known insurance inspector and engineer, gives in graphic form the number of all fires in twelve factories during the seven years previous to 1915, and the number of spreader fires in seven factories during that same period. It will be seen that a very large percentage of all occurring in the winter were spreader fires. This engineer believes that this fact suggests some peculiarity in the condition of the atmosphere, such as dryness, as the probable cause, and calls attention to the humidity of the inside air in the different months. It will be observable that the line thus represented follows remarkably near parallel with that representing the total fires in those months.

Mr. Hoxie says:—

More fires are reported in rubber factories in winter than in summer. At first view this might appear to follow the greater amount of artificial lighting required, or to be influenced in some way by the artificial heating of the premises, but on closer view sparks of frictional electricity and the presence of combustible vapors are found to be important elements in the problem. This periodicity of fires ignited by a spark of frictional electricity suggests some peculiarity in the condition of the atmosphere, such as dryness, as a possible cause.

The maximum amount of water vapor which it is possible for a cubic foot of air to contain increases with the temperature, and is, therefore, greater in summer than in winter. The effective moisture in the air is most conveniently measured by what is called the "Relative



Distribution of rubber factory fires reported for seven years.

The upper curve is the monthly average mean of dew points at 8 a. m. and 8 p. m. at Boston, thus representing fairly well daytime conditions or "working hours" in southern New England.

The second curve is the aggregate number of rubber fires reported in twelve factories, distributed by months, in the same seven years.

The lowest curve shows the aggregate number of rubber spreader fires reported in seven factories distributed by months during the same period.

humidity," which is the ratio which the amount of water vapor present in a given space bears to the greatest amount of water vapor that it is possible for that space to contain at the same temperature and barometric pressure.

The "Dew point" is the temperature at which drops of moisture just commence to form, or the temperature at which the moisture present is just sufficient to fill the space without precipitation.

The condition of textile fibres follows the relative humidity and not the absolute amount of moisture in the air. They take up moisture when the relative humidity is increasing and give it up when it is decreasing.

The relative humidity inside an ordinary room which is not provided with special moistening apparatus becomes much lower in winter than in summer, and it has been said that measured by relative humidity the air in an ordinary living-room becomes dryer than that over the desert of Sahara in summer; therefore, fabrics or other absorptive materials become dryer in a heated building in cold weather than in the air in its outdoor condition in summer, or winter. This condition of dryness causes static electricity to manifest itself in the form of sparks, such as those observed when one strokes a cat on a cold winter's day. In rubber manufacturing processes where volatile and readily inflammable solvents are used, these sparks may ignite the combustible vapors.

The mere raising of the temperature of the external air when taken into a heated building greatly lessens its relative humidity, although the absolute amount of water in it or the number of grains per cubic foot remains the same. It is *relatively* far dryer than before.

The lowest average monthly dew point of the outside air at Boston for the past twelve years occurs during the month of February and is 17 degrees Fahrenheit with a range from 11 degrees to 21 degrees.

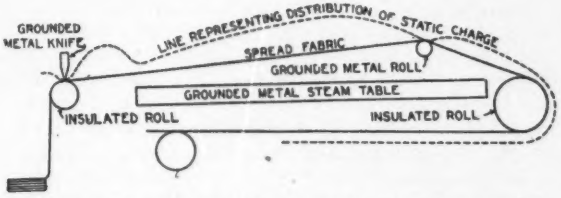
Taking outside air that contains sufficient moisture (0.816 grains per cubic foot) to cause a dew point of 11 degrees Fahrenheit, in other words, air that is saturated or has a relative humidity of 100 per cent at a temperature of 11 degrees Fahrenheit and bringing this into a room where a temperature of 60 degrees Fahrenheit is maintained, the change in temperature with no change in grains of water per cubic foot, causes the relative humidity to decrease from 100 per cent to 14 per cent.

When the dew point is at the highest average February range of 21 degrees Fahrenheit, the air contains 1.294 grains of water per cubic foot, and the relative humidity of this air, which is 100 per cent at 21 degrees Fahrenheit, becomes 23 per cent when its temperature is raised to 60 degrees Fahrenheit.

About three-quarters of the fires reported by rubber factories are in cold weather, as shown by the diagram giving the number of fires each month and the average monthly dew point of the inside air.

Humidity measurements were made on a winter's day in the spreading room of a rubber factory in Canada, while the relative humidity of the room was gradually increasing after a cold morning in which excessive electrification was noticed. Just after static electricity had ceased to be conspicuous on the goods, and at a temperature of 58 degrees Fahrenheit, this engineer found a relative humidity of only 28 per cent. In summer the air from the outside entering this room would have an average relative humidity of from 60 to 80 per cent., or would contain five times as much water per cubic foot.

The observations plotted in the diagram suggest that a comparatively low atmospheric humidity is sufficient to stop most of the fires caused by static electricity, and that the natural humidity is enough to present fairly safe conditions during the greater part of the year.



Distribution of static electricity on fabric on a rubber spreading machine on a cold day.

The remedy suggested is a simple humidifying device or a small steam jet opened in cold, dry weather. This would be sufficient to raise the humidity in the room above the danger point; also it appears probable that in rubber factories, in addition to preventing fires, a carefully regulated humidity will improve the quality of the goods, although no conclusive data on this point are yet available.

In the rubber spreading room, above referred to, the distribution of electric charge on goods being spread was roughly determined by the use of cotton candle wicking, as an electroscope, while the relative humidity in the room was at about 20 per cent. The sketch above shows the distribution of the electrical charge. An electroscope of worsted fibres would have been somewhat better, but cotton was used, as being at hand. A gold leaf electroscope would probably be found too sensitive for indicating the comparatively large differences of charge.

The cause of the electric charge on spread rubber has been attributed to friction at the knife. This may contribute to it, but its distribution would indicate that it is more probably caused by the evaporation of the solvent from the cement or from some unknown chemical action, such as oxidation or change in hydration of the

rubber or fabric. For example, kerosene passed through wool filter bags can develop a sufficient charge of electricity to ignite the kerosene.

Some experiments carried out in the Factory Mutual Laboratories show that the act of withdrawing a piece of loose wool from a pail of benzene leaves an appreciable electric charge both on the wool and the benzene.

Electrical devices making use of very high voltage alternating current have been applied successfully for neutralizing the static charge on calendered paper. This device has been tried in a few cases on rubber spreaders with doubtful success, and sometimes fires have been directly caused by it.

Ozone from electrical devices, or from the electrified goods themselves, may also have a detrimental effect on rubber, for ozone appears to be a natural enemy of rubber. One of the old-time practical tests for durability of a sample of rubber was to place it in a closed jar in which ozone was slowly generated by the presence of a small piece of phosphorus.

Last winter, one rubber factory installed a recording hygrometer in a room where much rubber cement is used and where fires have frequently occurred. Whenever the humidity falls below 45 per cent., moisture is blown in or the air is artificially humidified. No fires of importance have occurred in this room since these precautions were taken.

Systematic observations of the relative humidity are now being made along the lines suggested above at several rubber factories. Until more reliable data are available, it will undoubtedly be safe to assume that with a relative humidity of not less than 40 per cent., the tendency to fires from static electricity about rubber cement will be much reduced, with no damage to the goods.

Mr. Hoxie advises that a reliable hygrometer be kept in each churn room or spreading room of a rubber factory, and, when the natural humidity falls below 40 per cent., artificial humidity should be introduced. This can be done by a steam jet or by some of the various forms of humidifiers used in cotton spinning rooms and weave rooms.

Department of Fire Record.

"Large Loss" Sprinkler Fires.

This study is based on the reports of the 18,795 sprinkler fires which were tabulated in the Annual Summary published in the *Quarterly* for *April*, 1917. Those fires in which the loss was reported as large—or where the loss amounted to $5,000 or more, when figures were given—were separated and distributed under the heads under which the whole of the sprinkler fires are distributed in Table 9 of the Annual Summary. Those occupancies which had a representation of more than 100 fire reports in the Summary are individually dealt with in the present analysis, the remainder being treated as a single group. It will be observed that more than five-sixths of the total number of fires occurred in the more common occupancies, although the proportion of "large loss" fires in these occupancies was only a little more than three-fourths of the whole. In addition to showing what proportions of the total number of "large loss" fires in the various classes of occupancy occurred where the sprinklers entirely extinguished the fire, where they held it in check, and where they failed, respectively, the tabulation gives information as to the average number of sprinklers opening except in the case of "unsatisfactory sprinkler" fires.

Beyond ascertaining to what extent sprinkler failure was identified with large loss, little attention is given on the present occasion to the "unsatisfactory" cases. These come in for attention in the ordinary way, and the factors that produce sprinkler failure are better known than laid to heart by those responsible for the maintenance of sprinkler equipments. The object has been to present in statistical form data regarding the conditions, other than those directly connected with the operation of the sprinkler system itself, which hamper the efficiency of the automatic sprinkler as a property-saving agent. It will be noticed that sprinkler failures are responsible for less than a half of all "large loss" fires, and in some important occupancies the proportion sinks to a quarter, or even less. The proportions and averages obtained from the totals in the tabulation have been regarded as constituting rough standards of normality, and the results of investigation of the more striking variations from these rough standards will be found appended to the tabulation.

Table showing the distribution of "Large Loss" Fires in sprinklered properties and the average numbers of sprinklers opening.

Occupancy.	Sprinklers Extinguished Fire			Sprinklers Held Fire in Check			Sprinklers Unsatisfactory		Total "Large Loss" Fires	Total Sprinkler Fires	Per Cent. in which there was Large Loss
	No. of Fires	Per Cent. of "Large Loss" Fires	Average No. of Sprinklers Opened	No. of Fires	Per Cent. of "Large Loss" Fires	Average No. of Sprinklers Opened	No. of Fires	Per Cent. of "Large Loss" Fires			
Automobile and Bicycle Factories	..	....	....	2	40.0	71.00	3	60.0	5	101	5.0
Boot and Shoe Shops	19	38.0	5.11	15	30.0	11.66	16	32.0	50	525	9.5
Carpet Mills	1	5.9	16.00	9	52.9	18.00	7	41.2	17	190	8.9
Carriage Factories	..	....	....	3	37.5	43.33	5	62.5	8	126	6.3
Celluloid (Pyroxylin Plastic)	4	18.2	37.00	4	18.2	51.33	14	63.6	22	126	17.5
Clothing Factories	38	61.3	7.03	19	30.6	13.22	5	8.1	62	508	12.2
Cordage Works	4	13.8	22.00	17	58.6	27.00	8	27.6	29	265	10.9
Cotton Mills	15	17.4	20.87	33	38.4	26.67	38	44.2	86	4793	1.8
Cotton Warehouses	3	12.0	20.33	7	28.0	42.66	15	60.0	25	210	11.9
Department Stores	8	30.8	14.50	11	42.3	26.90	7	26.9	26	348	7.5
Drug Houses	3	21.4	42.66	7	50.0	76.42	4	28.6	14	137	10.2
Dyeing, Bleaching and Finishing	2	12.5	44.00	8	50.0	45.00	6	37.5	16	185	8.6
Electrical Appliances	1	12.5	73.00	4	50.0	5.25	3	37.5	8	120	6.6
Foundries	..	....	....	3	37.5	44.00	5	62.5	8	175	4.6
Furniture Factories	14	20.6	31.36	23	33.8	45.43	31	45.6	68	551	12.4
Jewelry Shops	5	71.4	8.60	..	....	....	2	28.6	7	105	6.6
Knitting Mills (Full Process)	10	21.7	14.30	17	37.0	29.31	19	41.3	46	596	7.7
Machine Shops	1	6.7	33.00	8	53.3	49.50	6	40.0	15	311	4.8

Mattress Factories	1	33.3	4.00	2	66.7	24.00	..	....	3	270	1.1
Mercantile	28	48.3	9.32	19	32.7	24.11	11	19.0	58	692	8.4
Metal Workers	6	17.1	18.33	13	37.2	98.00	16	45.7	35	697	5.0
Musical Instrument Factories	2	16.7	14.00	6	50.0	23.00	4	33.3	12	118	10.2
Paint and Color Works	..	....	....	3	42.9	23.66	4	57.1	7	145	4.8
Paper Box and Papeterie	1	14.3	9.00	5	71.4	97.60	1	14.3	7	108	6.5
Paper Mills	5	10.0	18.60	17	34.0	90.31	28	56.0	50	473	10.6
Printing and Lithographing	9	33.3	4.00	6	22.2	32.00	12	44.5	27	417	6.5
Rubber Works	1	11.1	1.00	5	55.6	32.60	3	33.3	9	154	5.8
Saw and Planing Mills	2	5.1	1.50	5	12.8	101.00	32	82.1	39	141	27.7
Shoddy Mills	3	17.6	22.00	6	35.3	25.66	8	47.1	17	215	7.9
Tenant Manufacturing	15	32.0	10.00	16	34.0	37.31	16	34.0	47	502	9.4
Warehouses	10	27.8	25.10	17	47.2	55.12	9	25.0	36	234	15.4
Waste and Batting Mills	1	10.0	19.00	5	50.0	47.40	4	40.0	10	269	3.7
Weaving Mills	11	50.0	11.82	8	36.4	18.62	3	13.6	22	128	17.2
Woodworkers:											
A.—Interior Woodwork, etc.	..	....	....	5	20.0	45.00	20	80.0	25	194	12.9
B.—Box Factories	..	....	....	5	21.7	25.20	18	78.3	23	198	11.6
C. Steam Power, Tenant and Miscellaneous Woodworkers	1	16.7	13.00	1	16.7	186.00	4	66.6	6	145	4.1
D.—Sash, Door and Blind Factories	1	7.7	2.00	1	7.7	49.00	11	84.6	13	114	11.4
E.—Hard Wood Turning	2	22.2	5.00	5	55.6	71.80	2	22.2	9	130	6.9
Woolen Mills	9	13.8	14.33	13	20.0	32.23	43	66.2	65	1023	6.5
Totals for selected occupancies	236	22.9	14.29	353	34.2	40.15	443	42.9	1032	15739	6.6
All other occupancies	51	15.7	24.90	104	32.1	46.49	169	52.2	324	3056	10.6
Totals for all occupancies	287	21.2	16.15	457	33.7	41.60	612	45.1	1356	18795	7.2

Boot and Shoe Shops.

The excessive proportion of "large loss" fires in cases where there was no sprinkler failure is explained very largely by the susceptibility of the stock to damage by water. Although the number of sprinklers opening is well below the average, water damage was the outstanding cause of the heavy losses. In view of the vital importance of preventing unnecessary flow of water in this class of occupancy, one would expect special attention to be paid to efficiency of alarm service; but, as a matter of fact, no less than six instances of complete failure of the alarm systems were reported. Obsolete devices, thermostats so placed that they were more readily accessible to water from neighboring sprinklers than to heat from incipient fire, and even the complete absence of alarm systems are among the factors noted as contributing to heavy losses in these six and other instances. In one case a small flash fire had partially fused a sprinkler head before it was extinguished. The water forced its way out after the factory had closed down, and, there being no approved alarm system, hours elapsed before the mischief was discovered. Poor construction, which permitted water to pass rapidly through floors, materially aided in increasing the loss in several cases. Obstructions to water distribution, and delays in shutting water off the sprinklers after they had done their work, are also noted among the explanations given to account for excessive losses.

Clothing Factories.

Less than 10% of the large losses in this class of occupancy were attributed to sprinkler failures. Five complete failures of alarm service resulting from neglect or defective installation were reported. There were also a number of cases in which inadequate service distinctly contributed to the loss. A single outside alarm unintelligently located proved insufficient in more than one case to secure prompt notification of the fire. In no less than seven cases serious delay occurred in shutting water off the sprinklers, either because there was no watchman, or an unsatisfactory watchman. Many clothing factories are on the upper floors of large buildings devoted to a variety of occupancies, and apparently there is apt to be much confusion in such buildings as to the locations of the controlling valves of the sprinkler systems. The construction of the buildings often leaves much to be desired, and obstructions from cutting tables, shelves and stock racks were frequently reported as delaying the extinguishment of the fire and causing unnecessary water loss.

Department Stores.

Their location in congested "down town" sections renders department stores peculiarly vulnerable to severe exposure hazards. No less than 8 of the 19 large losses without sprinkler failure, were due to exposure fires, but it need hardly be said that in all these cases the loss by fire would have been incomparably greater had not the sprinklers kept the fire from gaining a hold in the menaced buildings. Susceptibility of stock to water damage was another condition making for heavy loss, and, as in clothing factories, some establishments paid dearly for

delay in shutting water off the sprinklers at the proper time. In one case a platform which had been erected on the floor prevented the water from flowing away through the scuppers, and in another instance a very heavy loss was incurred in an even more unusual manner. Fire occurred in a cold storage room having an area of 4,000 square feet, and stocked with furs of great value. Owing to the operation of a blower the heated air was chilled, as fast as it rose, by cold air, and a fan kept the air in constant motion. Hence there was not sufficient heat to open the sprinkler heads until the fire had gained sufficient volume to raise the temperature faster than the inflow of cold air lowered it. The fire had in all probability been burning for some hours before it was discovered by a night watchman. Notwithstanding these extremely unfavorable conditions, the sprinklers were able to extinguish the fire completely when at length they operated.

Mercantile.

As might have been expected, the predominent cause of heavy loss in mercantile establishments, when sprinklers operate satisfactorily, is the susceptibility of the stock to water damage, this being given as a reason in no less than twenty instances. The arrangement of the stock is also an important factor. In a number of cases, congested or badly arranged stock interfered with the efficiency of sprinklers and scuppers, and sometimes, by causing the fire to give off dense smoke, made it impracticable to shut water off the sprinklers as soon as would have been safe if the real extent of the fire could have been ascertained. The absence of alarm systems and unreasonable delay in shutting water off the sprinklers are among the other causes. At one establishment sprinklers were allowed to continue operating all night after the fire had been extinguished. The result was a water damage of more than $80,000. The refusal of the fire department to use the steamer connection to increase the pressure on a weak system was reported as a factor in one large loss. Only two complete failures of alarm service were recorded, but there were instances where no alarm system had been installed. Poor construction was held responsible for one or two losses from water leaking through floors.

Tenant Manufacturing.

Poor construction permitting water to leak readily through the floors was a feature in ten of the large loss fires in this class of occupancy. Susceptibility of stocks to water damage and obstructions to distribution account for most of the remainder. Three complete failures of alarm service were reported.

Warehouses.

The responsibility for the large losses in warehouses rests almost entirely upon poor arrangement of stocks and their susceptibility to water damage,—particularly the former. In case after case it was found either that the distribution of the water from the sprinklers was obstructed, or that the arrangement was such that the fire-fighters could not get near enough to the seat of fire, or that there were no skids, or that all of these conditions existed together.

Weave Mills.

The large loss fires in this class present no special feature except that there were three instances in which incompetent fire-fighting was a factor in producing a large loss. The remainder of the fires belong to one or other of the classes enumerated under previous headings—susceptibility of stock, obstructions to distribution, poor construction, etc.

General Conclusions.

The seven classes of occupancy selected for special comment were chosen because in them the proportion of fires in which the sprinklers operated satisfactorily without averting a large loss was exceptionally large. It is remarkable that, except in warehouses, the average numbers of sprinklers opening in "large loss" fires in these occupancies were below the normal. This proves that the causes of the losses are not to be sought in flash fires or other conditions of which the sprinklers were not able to take care rapidly enough. As a matter of fact, in those classes of occupancy in which quick fires are to be expected, the sprinklers, except where they fail altogether, make a good showing as property-savers. In every one of the seven classes the bulk of the large losses are traceable directly to causes which would have operated detrimentally whether sprinklers had been installed or not. The reports make it abundantly clear that many of the poorly constructed buildings in which heavy water damage occurred would, without sprinklers, have been completely gutted. The losses also in the severe exposure fires, although heavy, are small in comparison with what they would have been without sprinkler protection. It is, however, impossible to take so complacent a view of a large proportion of the fires. In very many cases the good work of the sprinklers was hampered or wasted by the failure of the management to realize such facts as that sprinklers cannot do their work properly if the distribution of the water is obstructed, and that water loss is almost bound to follow if there is only one man connected with the plant who is familiar with the system, and he happens to be absent when the fire occurs. The recklessness and indifference shown in many sprinklered plants indicate that the automatic sprinkler is still too widely regarded as a device for reducing merely the insurance premium of the individual rather than for reducing the fire waste of America.

Result of Gasoline Explosion in Dry Cleaning Establishment.

Dry Cleaning Establishment Explosion.

Report by Charles H. Patton

(Member N. F. P. A.)

Fatal Gasoline Vapor Explosion, Cleveland, Ohio, Sept. 10, 1916.

The accompanying photograph shows the result of a gasoline explosion in the dry cleaning establishment of The Davis Laundry Company on the afternoon of September 20, 1916. Two men were killed as the result of the explosion, and a section of the dry cleaning establishment, which was of a light grade of fireproof construction, practically blown to pieces.

It seems that the explosion occurred in the dry room. Some garments being washed were removed from the gasoline wash room and placed in the dry room. Shortly afterwards the explosion occurred. Evidently the garments were too wet when placed in the dry room, and it is believed that the explosion either occured from rapid vapor arising therefrom, or from some other formation of gas.

No fire to speak of followed, on account of the construction of the building and the small amount of combustibility therein. The building exposed the main laundry building about thirty feet distant, and the explosion broke the window panes in the exposed wall. Quite a panic followed in the laundry among the 300 working girls employed.

An apartment house located about forty feet away had a similar experience with its tenants.

The gravity tank supplying water to the sprinkler equipment was located but a few feet away from the building destroyed, but, strange to say, the structure was not damaged. Had the supports been damaged, the tank no doubt would have fallen on the laundry or apartment house, and caused much additional loss of life.

This is a strong argument for requiring hazards of this kind to be located in unexposed spots outside of the city fire limits.

Fire in Central High School, Pueblo.

Special Report by Rocky Mountain Fire Underwriters' Association, G. W. Brinsmaid, Manager.

(Member N. F. P. A.)

Construction.

The school was a three-story and basement brick joisted building, having an area of approximately 25,800 square feet, in three divisions, without cut-offs. The main supporting members were steel I-beams resting on brick partition walls. The floor joists were of wood 6 by 10 inches; the ceilings were sheathed with metal lath and plaster leaving concealed spaces. There was a blind attic, from 6 to 8 feet in height, with the entire roof space communicating. The roof was of metal on ⅞-inch matched lumber. The floors were, in the basement concrete and wood, and in first, second and third stories 2½-inch splined plank with ¾-inch wood surfacing. The attic was floored with ⅞-inch rough lumber. There were two open stairways from the basement to the third floor, and one tile enclosed elevator shaft which was blocked up, not being used. Partitions were brick and 6-inch hollow tile resting on steel I-beams.

Occupancy.

Basement: Boilers and heating plant (boilers used for heating only); manual training power wood working machines; occasional painting and varnishing and class rooms.

First Floor: Gymnasium, cafeteria for serving lunches to students (cooking devices safely arranged); class rooms and auditorium.

Second Floor: Domestic science (cooking and sewing, coal fuel range on wood floor, no protection); class rooms and office.

Third Floor: Physics and chemical laboratories; storage of chemicals; class rooms and several unfinished rooms.

Private Protection.

Two 1½-inch standpipes with 75 feet 1½-inch hose and nozzle attached, each floor; five 2½-gallon chemical extinguishers distributed in building.

Public Protection.

Pueblo fire department, two stations, four and twelve blocks distant; six hydrants within two blocks of risk from 12, 10 and 6 inch circulating mains; 40 to 45 pounds static pressure at street grade; Gamewell fire alarm station in entrance to basement.

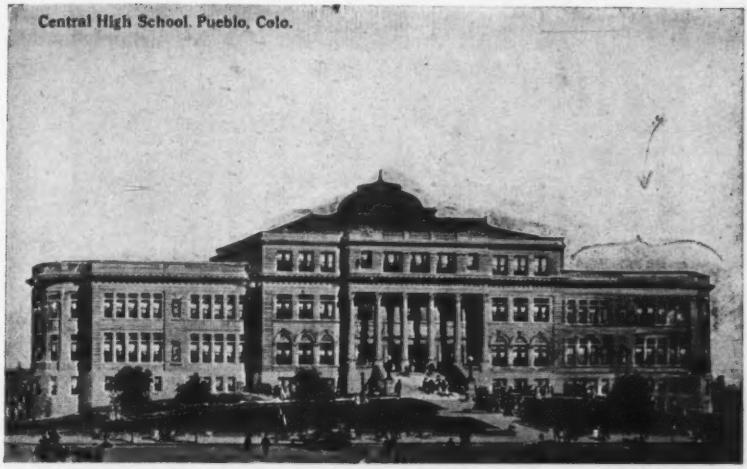


Plate 1. The building before the fire occured. The section that did not burn is indicated by the arrow.

Details of the Fire.

Fire started on third floor of west wing between 2:00 and 2:30 a. m., February 28, 1917.

According to the fire chief, an alarm came in by telephone about 2:45 a. m.; department immediately responded with entire equipment, consisting of one 700-gallon gasoline pumping engine, one 1,000-gallon steam pumper, one 75-foot aerial ladder truck, one combination chemical and hose truck; four 35 H. P. automobiles equipped with chemical tanks and hose. The steam pumping engine is drawn by 75 H. P. combination auto truck; and owing to the snow and icy condition of street, considerable trouble was experienced in getting it to fire. Seven hose streams supplied from the two pumping engines were used on the fire; owing to the low pressure on system at this point, hose streams direct from hydrants were of little or no value; pumping equipment was inadequate to cope with a fire of this magnitude.

Evidently the fire had been burning some time before alarm was turned in, as the roof was falling in on west wing when the first company arrived. A strong wind was blowing from the northwest and the fire started in the west wing. Hence the fire swept through the building very rapidly, the open construction and lack of fire stops also being responsible for the quick spread of the flames. The wind changed to a northwesterly direction during the fire, thereby assisting the firemen in saving a portion of the building known as the old wing, occupied as chemical and physical laboratories and class rooms. This section of building, which probably represents a fifth of the value, sustained heavy fire and water damage. The remainder of building was entirely gutted from first floor to

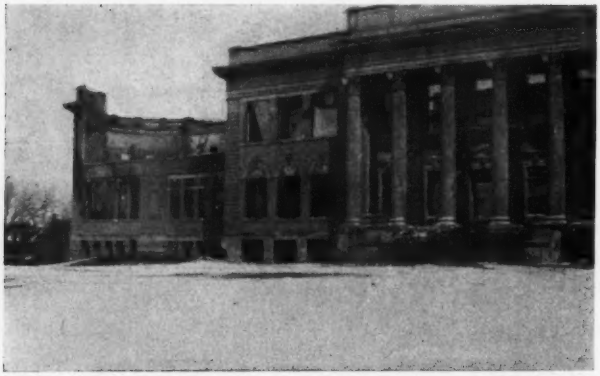


Plate 2. The wing where the fire started. The section of wall collapsed shortly after arrival of the fire department.

roof; a small portion of first floor, however, was saved, but will be of little or no value on account of its charred condition. The heat of the flames was so intense that structural steel throughout the building was very badly damaged, the majority of the members being reduced to scrap. The steel girders supporting roof gave way in the early stages of the fire. Firemen working inside narrowly escaped the falling debris, losing three lines of hose. Brick walls were heavily damaged by fire and heat and, in places, were left very much cut of plumb. Walls of building will probably have to be torn down and entirely rebuilt.

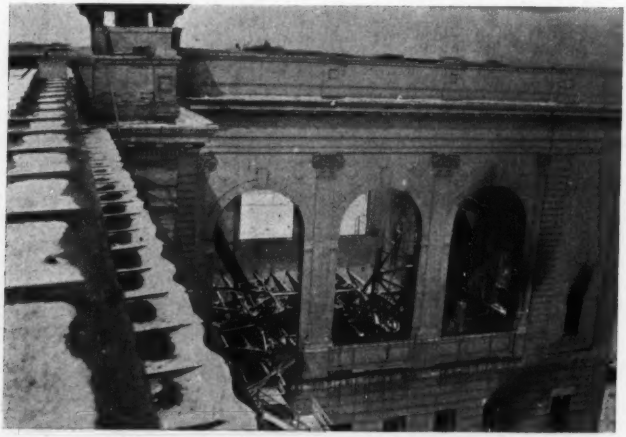


Plate 3. Auditorium section. The steel beams supporting the roof gave way in the early stages of the fire. Firemen working inside narrowly escaped injury from the falling roof.

Plate 4. Taken on first floor. Shows the destruction of upper floors which were of heavy joisted construction. The section shown was a hallway with no combustible material other than that used in building construction.

Conclusions.

As nearly as can be ascertained, the fire started in the west wing of the building on third floor in an unfinished section. Workmen had been using some of these unfinished rooms as a work shop

Plate 5. The brick partition in the foreground shows how walls stopped at attic line. Also note condition of unprotected steel beams.

and were cleaning out the same the day before the fire. It is very possible that the fire may have originated in some oily waste or rubbish left by the workmen, but there is no tangible evidence to substantiate this supposition. The open construction of the attic space was such that a fire would spread very rapidly throughout the entire building; and this, together with the interior combustible construction of the building and the headway made by the fire before it was discovered, rendered a quick and effective stop by the department practically impossible.

The equipment of the fire department is not adequate to cope with a fire of any magnitude in the low pressure sections of the city.

The total value of the building and contents exceeded $300,000.

Lessons of the Fire.

1. The building, owing to its large area and combustible construction, should have been provided with suitable fire stops, division walls should have been carried through roof, and openings through the same should have been equipped with automatic fire doors.

2. Night watchman service or automatic fire alarm equipment should be provided in all large buildings of such combustible and inferior construction.

3. A suitable tractor should be provided for the large steamer. The small automobile hose and chemical trucks now used should be replaced by triple combination automobile apparatus, the size and design of such equipment to be in accordance with the specifications of the National Fire Protection Association for automobile pumping apparatus. Complement of the fire department should be increased to fully man all apparatus.

Fire at Belmont Park, Nassau County, L. I.,

April 7, 1917.

Special Report by New York Board of Fire Underwriters.
(Member N. F. P. A.)

Belmont Park is a race track property, located in Nassau County on the Jamaica and Hempstead turnpike, just over the boundary of Queens borough of New York City, owned by the Westchester Racing Association. It consists of a mile and a half track, a mile track, also straight-away courses, a large and a small grand stand with betting pavilions adjoining to the rear; a large three-story brick club house, jockey house, receiving stable, two former mansions and about 75 other frame buildings consisting of stables, help dwellings, sheds, etc.

The interest in this fire lies in the fact that the conditions which existed and were responsible for the partial collapse of the big grand stand, might occur in any of the steel skeleton structures which are replacing the old time wooden stands. It emphasizes the extreme vulnerability of unprotected steelwork to fire fed only by frame walls, partitions, furniture and fittings.

Plate 1. Front of the grand stand. Note the deflection of the box floors and splintering of brickwork by the deflection of the columns. There were wood enclosed storerooms and telegraph office beneath the boxes at about this point. The collapsed portion (plate 3) starts halfway up the stand at the intermediate row of columns.

Construction.

The large grand stand was about 150 feet wide and 600 feet long and was reputed to have a seating capacity of 10,000 persons. The skeleton was of unprotected steelwork. The seating platforms started at a height of about 8 feet above the ground at the front and rose to a height of about 40 feet at the rear. They were divided into a front and rear section by a promenade extending the length of the stand; immediately to the rear of this walk was a series of boxes. Under the seat platforms at the rear was a mezzanine floor. The whole was covered by a roof 15 feet above the highest part of the stands. Walls were of brick 12 inches thick extending to first tier of boxes at front and 16 inches thick extending to mezzanine in rear, with large sash windows on all sides. Wooden partitions, enclosed toilets and other rooms on first story; on second, the rear of the mezzanine floor was enclosed by corrugated iron on wood and steel frame on the outside, and all rooms were ceiled with wood on the inside. Toilets and other rooms on the ground floor and restaurant, toilets, kitchen and other important rooms on the mezzanine all had wood ceilings.

Seating platforms were constructed of ¼-inch steel plate risers, supported on brackets on steel trusses to angle and plate columns; to the risers angle irons were riveted and to these angles permanent corrugated iron centering was bolted by ⅜-inch bolts 7½ inches on centers, a 3/16-inch strap being placed under the heads of the bolts

Plate 2. Central promenade. The collapse of the upper portion pulled over the steps leading to the upper tiers. The front of this portion was cement plaster on metal lath and stood up fairly well.

to prevent them from pulling through the iron; on top of the iron centering a 2½-inch rock concrete slab was poured to form the platform.

The ground floor was of cement on earth; the mezzanine had a cement finish on slabs and corrugated iron similar to seating platforms, a small portion had a ⅞-inch wood floor on wood sleepers filled between with cement. The roof consisted of composition, slag covered, on ⅞-inch sheathing on 4x4-inch purlins 3 to 4 feet on centers on 8-inch channel rafters on lattice steel trusses running lengthwise of stand, these in turn being supported by the main trusses.

All of the steel work was unprotected except those sections of front, side and rear columns which were built into the brick walls.

Occupancy of Grand Stand.

Ground floor—Storeroom, telegraph office, caterers' ice boxes and storeroom, old bottle room, rooms for special police, toilets, bars in center.

Mezzanine floor—Ladies' toilets, restaurant (45 square tables and 153 chairs); kitchen, large French range, steam tables, hot water heater, etc.; storerooms; toilets and storerooms contained about 1,700 chairs for grand stand.

Story of the Fire.

The fire was unquestionably of incendiary origin. Fires were set about 3:00 a. m. in the receiving stable, administration building (generally known as the jockey house), club house, at both ends of

Plate 3. Collapsed upper portion of grand stand. The seat platforms ran from the boxes at the left to the line of corrugated iron hanging from the columns at the right. The fire in the combustible material beneath the seat platforms caused the buckling of the supporting trusses and intermediate columns (some of the latter can be seen doubled over in the center of the picture.) This overloaded and caused the failure of the riveted joints where the trusses joined the columns at the top of the stand, and the latter fell throughout its whole length. The row of columns at the boxes are straight above the boxes, but many are deflected below. Note the arch construction and how the slabs are broken away from the corrugated iron, also the warped channel rafters of the roof construction.

Plate 4. Another view of upper portion of grand stand, showing construction of collapsed seat platforms, part of corrugated iron enclosing wall at rear and brick backing of French range in kitchen. A careful examination of the ends of the trusses showed where the rivets pulled through the angles. One of the collapsed intermediate columns is seen at the right.

the main grand stand, at the east end of the field stand, and in the platforms and sheds of the Long Island Railroad station, all within a short time of one another. The fire was discovered and an alarm turned in by one of two night watchmen who made hourly rounds, one covering the westerly and the other the easterly portion of the grounds. This alarm brought volunteer fire companies from Queens and Elmont; special calls brought fire companies from Jamaica and Brooklyn.

One and two way hydrants are located about 500 feet apart on an 8-inch underground main on the Hempstead and Jamaica turnpike; a 6-inch extension runs into the grounds with single 2-inch outlets about every 150 feet along the edge of the track. There was a hose cart with 1,000 feet of 2-inch hose on the premises. There was a 2-inch standpipe in the club house which was used to extinguish the fire there, also a 2½-inch standpipe in the jockey house, which building, however, burned to the ground. The fire in the receiving stable was promptly extinguished. In the east end of the field stand the fire burned out the wood sheathing which constituted the east enclosing wall of this structure and detroyed completely the frame toilet at that end, also burning up some of the bar fixtures before it was extinguished.

The limited facilities for fighting fire available were directed more toward saving the big club house than checking the fire in the grand stand. It is doubtful if any water reached the fire in the mezzanine floor of the latter and it burned fiercely for hours resulting in the collapse of the upper tier of seat platforms. The fire was still burning at 9 a. m.

Damage.

The damage to the first story of the main grand stand was most pronounced at the east end. Here twenty columns showed marked deflections. Here and elsewhere many beams and trusses were notably bent. The corrugated iron centering was very generally deflected, showing the inability of this form of construction to resist heat. The damage above the second or mezzanine floor can best be appreciated by examining the pictures and the description attached thereto, remembering that under the collapsed seat platforms were kitchen, restaurant, toilets and storerooms, wood ceiled and sheathed, with additional combustible material in the shape of about 1,853 chairs, 90 tables and other furnishings which burned unchecked. There were on top of the seat platforms 1,100 massive hardwood benches, each 4 feet high and long enough to seat comfortably four people.

The extent of the damage to the roof construction is not well shown in the views. The combustible woodwork burned entirely off, warping and twisting the channel rafters which were its immediate support. In the front part of the stand the roof trusses stood up very well, there being only an occasional slight deflection. At the rear, however, where they were subjected to additional heat from the burning material under the mezzanine and benches on top of seat platforms, practically every truss was badly warped and buckled. At the west end of the stand, the failure of the upper tiers of the seat

Plate 5. Under side of collapsed seat platforms, showing corrugated permanent centering. The failure of the supporting truss is typical.

platforms, pulled over the upper portion of the brick enclosing wall. The wood enclosing wall at east end of the field stand and wood enclosed toilets were burned out, deflecting beams and roof trusses.

Conclusions.

Properties such as the Belmont Park should have an underground system of piping of ample size with adequate water supplies, and with frostproof hydrants equipped with standard hose houses at suitable intervals. A well drilled private fire brigade is also important.

The burning of a large quantity of combustible material in a fairly small enclosed place, as in the mezzanine floor under the grand stand, is certain to bring about the collapse of unprotected steel work.

Frame enclosed rooms, as the boxlike toilets and offices on the first floor, contain enough combustible material, without the addition of combustible storage, to cause buckling of columns and warping of beams and trusses. Combustible roof covering if in a high open space will burn completely away damaging only its immediate supports. The additional heat from burning contents is, however, likely to cause a failure of roof trusses.

Safe practice demands that where combustible material exists, even in small quantities, steel supporting members should be fireproofed, or in the absence of such fireproofing the combustible material should be eliminated.

Unsatisfactory or Serious Fires in Buildings Equipped with Sprinklers.

When sprinklers fail the causes are almost invariably clear. These fires are selected to indicate such causes, that they may be generally understood and satisfactorily met.

S-19386. Woolen Mill. This fire occurred a few minutes after noon, just as the employees were going home to dinner. The cause is unknown, but the point of origin seems to have been on the first floor of a two-story frame building used on the first floor for storage and on the second for drying. The town water works were shut off during the repair of a break in the system caused by a hydrant being struck by lightning on the previous night. The only water supply to the sprinklers was a 5,400-gallon gravity tank giving a pressure of about 22 pounds on the first floor; and as this supply was insufficient to extinguish the fire, the building was soon destroyed. There were four windows in the end of a brick picker building next to the burned structure, two of these windows being in the first story and one each in the second and third stories. The frames of the windows were burned and the heat opened several sprinklers near them. The sprinklers were of great assistance in keeping the fire out of the picker house and the main mill, as the engineer, with two small feed pumps, kept them in commission by pumping water into the tanks. The good work of the employees was a very important factor in restricting the fire to the building in which it originated.

Summary: Primary water supply shut off.

S-19483. Wooden Box Factory. At the west end of this three-story factory, a shavings' vault extended from the second floor to a point about four feet above the roof of the main building. The walls above the roof were corrugated iron on wood and the roof was of one-inch boards on joists, slag covered. Adjoining the shavings' vault on the east is a smaller sawdust vault, built with concrete sides and extending above the roof in a similar manner to the shavings' vault. There was a partition between the two vaults, and the sawdust and shavings delivered by blower systems from the various machines passed through separators on top of the vaults. Both vaults were equipped with sprinklers, but those in the sawdust vault were kept shut off in winter to prevent freezing, and those in the shavings' vault were kept shut off permanently, as a result of the riser being pushed out of line by the weight of the shavings, the fittings becoming cracked, and some of the sprinklers opening. Fire apparently originated in the centrifugal separator, and was probably caused by a nail or other piece of metal revolving inside the separator until it became heated or struck sparks. Smoke was seen coming into the top floor of the main building through cracks around the

corrugated iron ends of the shavings' vault. Water was turned on to the sprinklers in the adjoining sawdust vault and two or three of them operated. The fire, which was of short duration, did considerable damage to the upper part of the shavings' vault, but was confined and soon extinguished by the city department.

After the fire the sprinklers in both vaults were placed on the dry system, and the riser was so arranged as to enter the vault at the top floor, so as to obviate the trouble caused by the weight of shavings knocking the piping loose.

Summary: Water shut off.

S-19684. Floor Covering Factory. The two-story building on the upper floor of which this fire occurred, was used for coating and drying paper felt. A paint mixture containing benzine (sometimes known as painters' naphtha) was put on the paper in a coating mill, the surplus paint scraped off with a steel knife, and the coated paper then drawn into racks, the stock being laid horizontally to be dried. There were four of these racks on each floor, with an aisle three feet wide between the racks and at the side walls. The racks were 10 feet wide and about 90 feet long. The rack room was separated from the coating room, which was 33 feet wide, by a wooden partition in which were rolling steel doors opposite the end of each rack. There were no floor openings in the building, and the only ventilation was obtained from an electrically driven fan, which discharged through a window at the west end of the building. The building was of plank and timber construction, the floors being of 2-inch tongue and grooved plank on bay timbers, set 6 feet 6 inches on centers, and the roof of 1¼-inch tongue and grooved plank on bay timbers (6 by 8 inches). These timbers ran across the building (55 feet) and were supported on the wooden uprights which formed the sides of the racks. The racks were formed of ½-inch iron pipes between the wooden uprights, with strap iron run horizontally to carry the coated felt paper.

The cause of the fire was a spark from static electricity as the south rack was being filled. The flames spread into the rack and also back to the coating mill. The private fire brigade turned out promptly and employees in the coating room attacked the fire with chemical extinguishers, of which there was a good supply on hand. The help of the public departments of the two neighboring towns was summoned. A chemical fire engine was brought up in the enclosed elevator shaft, and put in service in the coating mill. In the meantime sprinklers had operated and were discharging water in the rack. Hose streams also were being used, and the superintendent was anticipating that the fire would be well under control within a few minutes, when suddenly, about fifteen minutes after the discovery of the fire, the water from the sprinklers ceased, the smoke increased and rapidly became so dense that the superintendent and his men were compelled to withdraw into an adjoining building, closing the fire door behind them. The chemical fire engine had to

be abandoned, and was badly damaged before the fire was extinguished.

The failure of the sprinklers at this point is explained by the fact that additional buildings had recently been erected to the east of the existing group and that the 8-inch yard mains were being extended to supply the new sprinkler systems and additional hydrants. On several occasions the existing yard mains had been shut off at the various section valves provided, while connections were made for the new mains. On the morning of the fire, the sprinkler foreman had for this purpose shut down two section valves and had also closed the post indicator valves controlling the sprinklers in several buildings, including that in which fire occurred. While one of the 6-inch pipes was open and the men were cutting out the heads of the temporary cast iron plugs in two other 6-inch outlets, the fire whistle blew, and the foreman realizing the conditions, shoved one of the 6-inch post indicator valves into place on the open pipe, after which the valve was braced against the side of the ditch with boards. Pieces of burlap were quickly brought, and thrust into holes which had been cut in the heads of the temporary cast iron plugs, and these also were then braced against the sides of the ditch. The foreman then opened the valves which allowed the sprinklers in the burning building to operate. All this, however, took at least five minutes, and by that time the fire had gained enough headway in the center of the rack to burn the roof boards sufficiently to let down some of the hangers on two of the stringer lines of sprinklers here (50 feet long) and these two lines in falling, twisted or broke off two large fittings, one on either side of the 5-inch riser in the cross main running along the north wall of the building. This accident completely cut off the sprinklers at the roof above the drying racks, and the fire then began to spread in the upper part of the racks. It was at this point that the sprinklers were observed to be no longer operating.

It should be observed that in addition to the 108 sprinklers at the roof, there were also aisle sprinklers, about 7 feet above the floor, in each of the aisles, and that these were hung on adjustable hangers well fastened to the upright timbers of the racks. The lower sprinklers were not protected in any manner against water from the sprinklers at the ceiling above; but when these others were rendered useless, they continued to operate, and were instrumental in confining the fire to the upper part of the racks.

The diversion of water into hose streams and trouble with the plug at the end of one of the new yard mains caused a serious reduction in the pressure on the sprinklers in the coating room. Strangely enough the improvised plug arranged by the sprinkler foreman held well all through the fire.

The roof of the building was badly damaged, the beams and planking being charred throughout, and the roof itself being burned practically off in places. Damage was also serious in respect of stock on the racks, the coating mill and the chemical fire engine. The side and end walls were, however, comparatively little affected and

were able to be used in rebuilding. Some of the steel window sash were warped and bent with the heat, but many were in good condition.

The sprinklers did effective work during the few minutes that elapsed between the turning on of the water and the break in the system and there is every reason to believe that if the water had been turned on when the fire started, they would have confined the fire to the rack on which it occurred.

Summary: Water temporarily shut off.

S-19797. Tenant Manufacturing. In this case a sprinklered frame building in the form of three sides of a square was connected by a small unsprinklered passway on the second floor with an unsprinklered frame building which practically completed the square. The unsprinklered building was used for the processes of stiffening felt with shellac cut with alcohol. Shortly after 4 p. m. this latter building was struck by lightning. There was a violent explosion, accompanied by a flash, and the whole edifice seemed a mass of flames. The city fire department responded promptly, but just as the first hose stream was introduced through the space between the sprinklered and unsprinklered buildings, a second violent explosion took place, throwing to the ground the five firemen who were handling this stream. The presence of large quantities of shellac and alcohol in the burning building made the fire one of great intensity. Although the first explosion wrecked many of the outer and inner windows of the sprinklered building, the inside sprinkler system was undamaged. The pipe supplying the outside sprinklers at the severely exposed end of the building was broken off near the riser, apparently by the second explosion, and this system was therefore of little value. Indoors the intense heat caused a large number of sprinklers to operate at once, seriously overloading the system. In all 233 heads operated, but the system was an old one, and the heavy draft upon the water mains reduced the pressure considerably. Hence very little water was discharged from the sprinklers on the third floor, and none at all on the fourth floor.

The city fire department saved the building, doing excellent work in preventing the spread of fire and protecting adjacent property. The structure was heavily charred on the outside and in some places for some distance inward.

Summary: Severe exposure.

S-19827. Shoe Shop. Four distinct fires started at about 2 a. m. in this building. The watchman failed to discover them, and the alarm was given by an elderly lady residing two houses east of the property, who observed smoke coming into her room and, after vainly trying to locate the watchman, notified a neighbor. The water was clearly shut off the sprinkler system at the time of the fire, as (1) the automatic alarm failed, (2) an excessive number of sprinklers opened, (3) there was very little evidence of water on the ceiling above the sprinklers, (4) the post indicator valve was opened

after the fires started (water was noticed flowing from 2-inch drip valve), (5) the fire chief found water gushing from a bad break in the system and ordered the watchman to close the post indicator valve in order that he might obtain effective hose streams.

Summary: Sprinkler system tampered with.

S-19925. Woodworker (Interior Trim). The outlet from the shavings bin was but a few feet from the door of the fire box, and back draught is supposed to have ignited the shavings. The two sprinklers in the bin were disconnected and out of service. Owing to the hopper shape of the bin there was an opening, up through shavings and sawdust, to the top part which seems to have been filled with dust. Fire spread rapidly up through this opening and a dust explosion occurred, throwing off a poorly hung fire door and allowing the flames to enter the second floor of the main mill. The roof was rapidly enveloped in flames. The effect of the sprinklers was negligible, contributory factors to their failure being the rapidity with which the fire spread, the explosion, and the slowness of operation of the old type of sprinklers.

Summary: Obsolete system, and that partly out of commission.

S-19948. Cooperage Plant. Details of the destroyed buildings at this plant are as follows:

(1) *Cooperage.* Iron-clad, open finish. One equal to one and a half stories in height, 33,000 square feet in area. Composition roof on 1-inch boards and rafters. Floor of earth and plank. Ceiling open joisted. Building communicated with dry kilns on the north.

(2) *Dry Kilns.* Fire-resistive construction. One story in height. West kiln 9,000 square feet, east kiln 6,840 square feet in area. West kiln divided in four compartments, east kiln into three, by 8-inch hollow tile walls to roof. Asphaltum roof on 6-inch concrete and tile. Earth floor. Ceiling smooth concrete. Both kilns communicated on the north with planing shed and on the south with cooperage. Doors at ends of kilns were of ¼-inch asbestos attached to wooden strips.

(3) *Planing Shed.* Open at sides. One story in height; 16,500 square feet in area. Composition roof on one-inch boards and rafters. Earth floor. Ceiling open joisted.

(4) *Engine Room, Pump and Fan Room and Shavings' Vault.* Fire-resistive and incombustible construction. One equal to one and a half stories in height. Hollow tile walls, 8 inches thick. Metal roof on metal trusses and 6-inch concrete and tile. Floor of earth and concrete. Ceiling smooth concrete.

(5) *Boiler Room.* Open on north and east sides. One equal to one and a half stories in height. Metal roof on metal trusses. Floor of earth and brick.

All buildings, except the office and a recent addition to the warehouse, engine room and saw shed, were equipped with a dry-pipe

sprinkler system which was supplied by two 50,000-gallon steel gravity tanks, located on 100 and 70-foot towers, respectively. The static pressure was from 30 to 43 pounds at the grade floor and from 13 to 30 pounds at the highest parts of the system. The private protection also included six 1½-inch vertical pipes in the cooperage and four similar pipes in the planing shed, these pipes being supplied by a 300-gallon duplex pump taking suction from a deep well. There was likewise a good supply of water barrels and fire pails. Three standard double hydrants were located at different points, two of them being furnished with 200 feet of good 2½-inch cotton rubber-lined hose with 1 inch nozzle, and the other with 250 feet of hose. The nearest fire department was a volunteer department located about ¾-mile distant and very poorly equipped.

The cause of the fire is unknown. The outbreak was discovered at 2:30 p. m. by a shipping clerk who noticed smoke issuing from a point near the south end of the west dry kiln. Almost immediately the electric alarm bell attached to the dry-pipe valve commenced to ring. The engineer sounded an alarm and stopped the fan which was supplying hot air to the dry kilns. Hose streams were used with the hope of at least confining the fire to those sections of the kilns in which it had originated, and the operation of sprinklers in the kilns prevented the flames from gaining very much headway. In response to a call for assistance, the volunteer fire brigade arrived at the plant at about 3:25 p. m., the fire at that time being confined to kilns Nos. 1 and 2. Twenty minutes later, aid was asked of the department of a large city about six miles away, with the result that two automobile pumping engines of 700 and 800 gallons per minute capacity and one truck arrived at about 4 p. m., in charge of the chief and assistant chief of the city. The pumping engines were not immediately used, as it was thought that no water was available for them. **An attempt to secure additional water from a neighboring plant proved ineffectual, as the fire department hose would not fit the plant hydrants.** At 4:30 p. m. the heat from the burning kilns, or possibly fire passing through a 4-inch metal hot air duct in the 8-inch hollow tile division walls, caused sprinklers to operate in kiln No. 3, and at about the same time, holes were punched in the roof and wall and streams directed into the interior of kiln No. 1. By 5 p. m. the water from both the elevated tanks was exhausted and the only water available was supplied by small pumps in the pump and fan room. The tanks were then shut off, so that water might be pumped directly into yard mains and sprinkler system. The supply was, however, so small that the use of two of the hose streams had to be abandoned.

Shortly after this it was discovered that water was obtainable from a bayou just west of the plant, and this supply was increased by opening both outlets of a double hydrant in the adjoining village and allowing water to run into the creek leading to the bayou. A private pump was also used to pump water into the creek. The water from the bayou was used by the pumping engine, and a line of hose was run to the kilns. By 5:30 p. m. kilns Nos. 1 to 4 were

all burning, but it was not until 6:20 p. m., when the doors at the north end of the kilns gave way, that the fire spread beyond them. As soon as the doors failed, however, fire flashed through the planing shed, causing the sprinkler heads to open. Lack of water prevented the sprinklers from controlling the fire here. The fire immediately spread also to kilns Nos. 5, 6, 7 and through the south end of the kilns to the cooperage. The engineer was forced by the heat to abandon his pumps, which he left in operation at 6:30 p. m. Before leaving the pump room he had the fires in the boilers drenched, and the water withdrawn, so as to reduce the damage to a minimum. In a few minutes the fire had spread through the entire cooperage, and the efforts of the firemen were directed to saving the warehouse south of the cooperage and fighting the fire in the lumber yard to the west. A brick fire wall on its north side prevented the fire from gaining entrance to the warehouse, although this was but 25 feet distant from the cooperage. The wall had four large openings protected by steel rolling doors which operated satisfactorily.

Among the lessons taught by this fire are:

(1) The vital importance of unobstructed distribution of water from the sprinklers. In this case the high piling of staves on trucks within the dry kiln—a very common practice—prevented water from percolating through the stock to the seat of fire.

(2) The need for good judgment in the use of hose streams. The water supply available for the sprinklers was reduced by more than 40,000 gallons through two hose streams used by the private fire brigade before the city department arrived.

(3) The folly of building dry kilns adjoining and communicating with main buildings. A very small clearance would in all probability have sufficed to save the major portions of the plant.

(4) The desirability of subdividing large areas with fire walls, even though the plant is under sprinkler protection.

Summary: Obstructions to distribution.

S-19970. Furniture Factory. This plant comprised a sprinklered and an unsprinklered section, the two being connected by an unsprinklered corrugated iron on wood stud passageway on the second floor. The door opening on the sprinklered side was protected by a standard wood tin-clad, automatic closing fire door. The fire started in the unsprinklered section, probably as a result of careless smoking. In order to throw water upon the fire, two lines of hose were taken through the fire door from the sprinklered building into the passageway, and the door blocked open with a brick. At about this time the heat caused sprinklers to operate to the annoyance of the firemen and they had the controlling valve closed. Shortly afterwards the fire became hotter, owing to the ignition of stock stored in the passageway. The firemen were compelled to retreat with the fire following them.

The unsprinklered section of the plant was a total loss, and over $20,000 damage was done in the sprinklered section before the water

could be turned on to the sprinklers sufficiently to enable them to extinguish the fire.

The city fire department was in a very unsettled condition at the time of the fire and there was a serious shortage of officers.

Summary: Water prematurely shut off.

S-20418. Automobile Assembling Factory. The brick arch of the boilers at this plant had fallen away some days before the fire, making it necessary to shut off the heat. The steam pipes froze and the sprinkler pipes were drained and the controlling valves shut, to prevent the systems from freezing and bursting. A gang of steam fitters was commissioned to thaw out all steam pipes, for which purpose they used blow torches. At the time of the fire sufficient heat had been provided for the main portion of the plant, and five systems had been restored to service. The gravity tank had been drained, but the filling pump had been started.

About at midnight the workmen who were engaged in thawing the pipes, went out for lunch, and the fire was discovered at about 12:48 a. m. If, as seems to be the case, the cause was a blow torch in contact with framework, the fire had had the greater part of an hour's start before the first alarm was given. When the first engine company arrived the plant was thoroughly ablaze. A high wind was blowing and frequent explosions of gasoline aided the destruction. There were but four feet of water in the gravity tank and such of the sprinklers as were in operation were dependent upon a poor city supply. The engine companies failed to remedy this defect by prompt use of the steamer connection; and the consequence was that a large part of the plant was completely destroyed. The east wing was protected by a dry-pipe sprinkler system which operated and held the fire out of this section. A part of the west wing and of the center assembling building were also saved, together with a small stock shed.

This fire made it clear that brick walls parapeted at the roof do not form a satisfactory fire stop unless they are continued beyond the side walls. There is also little doubt that, if the steamer connection had been used promptly, a great portion of the south section of the plant could have been saved.

Summary: System drained to prevent freezing.

S-20612. Machine Shop. This plant consisted of three main groups of buildings. The edifice ruined by fire was the main building of the central group; it was occupied as a machine shop in connection with the making of switches and signals. The building was of brick, and was divided into two parts by a brick fire wall, parapeted 18 inches, the openings through which were protected by standard fire doors. The height of the building was one equal to two stories, except for a carpenter shop and pattern storage at one corner, which consisted of two stories. Mezzanine and platform floors had, however, been erected to a considerable extent in the one story portion. The entire structure was protected by a wet pipe

sprinkler system, each of the 13 risers having outside post indicator valve control. Fire was discovered at about 4 p. m. on Saturday afternoon in the section occupied for storage of office files and records. The riser controlling the sprinklers in this section had been shut off some time previously while a frozen pipe was being repaired. The valve was subsequently opened, but by that time the fire was beyond control.

Owing to heavy demands for heating purposes, the steam pressure had been allowed to fall very low, and there was consequently considerable delay in getting the steam pumps to work. The electric pumps also could not be started until a jumper connection to the public service had been made at the power house. Public fire departments responded from neighboring cities, but had to lay very long lines, owing to difficulties in getting water from the yard hydrants. The fire was carried past the parapeted fire wall, and, with the exception of the carpenter shop section, the whole building was destroyed. The loss was extremely heavy.

Summary: Water shut off sprinklers on account of freezing.

Fire Causes.

The fires here given are selected to illustrate defects either of construction or superintendence in the classes of property indicated.

Chimneys and Flues.

H-11707. Roofing Paper Mill. Fire originated in new addition to kettle room over an underground flue conducting hot gases from boiling kettles to economizer. The flue was covered with concrete, on top of which were ashes. In the ashes the end of a wooden stair girder was bedded, and the flue apparently heated the ashes sufficiently to cause the wood to ignite. The fire, which occurred while the plant was shut down, spread very rapidly and consumed practically all the woodwork in the room. A large amount of unprotected steel in the form of roof girders and crane shafting was so badly damaged by warping that it had to be replaced. Automatic fire doors into the main kettle room operated and no loss was sustained in that room. The automatic covers to the saturating compound kettles also operated. Loss exceeded $6,800.

S-19629. Wood and Paper Box Factory. Wood waste was used for fuel at this plant, and a burning brand from the stack, which was not provided with a spark arrester, set fire to shingle roof. Fire was discovered promptly and extinguished with water pails and chemical extinguishers.

S-19640. Wood Box Factory. The spark arrester on the boiler stack was of an unsatisfactory type, and apparently permitted sparks to ignite a small amount of sawdust on the roof of a dry kiln. Fire burned a small hole through the roof and spread along a joist channel, but was held in check by a single sprinkler.

S-19716. Bobbin and Shuttle Factory. During a high wind, which fanned the flames into quite a lively blaze before they could be extinguished, the shingle roof of this plant was ignited by sparks from the boiler house chimney.

S-19750. Machine Shop. Natural gas had recently been substituted for coal as fuel in a blueing furnace. The chimney was not properly lined, and it may have been weakened, or a soot fire started, as a result of the use of the new fuel. In any case, fire spread from the chimney to nearby woodwork, with a consequent loss of more than $1,000.

S-19999. Printing Establishment. Fire was caused by accumulation of rags and loose paper in contact with defective chimney from lead-melting stereotype pot. **The flue from this pot, which had a**

capacity of about four tons of molten metal at a temperature of 650° F., discharged into a brick chimney partly made up by a bearing wall of the building, and having no clearance from the wooden floors or roof! Only the prompt operation of three sprinklers in the attic in which the rags and paper were in contact with the chimney, averted a very serious fire. It is not surprising to find, in a plant working under the conditions described, that the only employee who understood the working of the sprinkler valves happened not to be on hand when the water needed to be shut off.

Electrical.

S-19691. Pay Roll Department of Machine Shop. Flexible cords for portable lamps and electric fans were in exposed locations under tables where they were subject to wear by contact with the feet of employees. Fire which damaged furniture and office material on tables is attributed to a lamp cord which had become worn in this way.

H-11740. Machine Shop. A 13,200-volt phase balancer set was being tested from a test stand provided with a K-5,300 ampere, 7,500-volt oil switch. The switch was open at the time of the trouble, but full voltage was on the terminals of the switch. Probably dirt on the surfaces of the insulating bushings at the top of the oil switch caused leakage over the surfaces, followed by short circuit and fire. Wooden enclosure of test stand and its two slate panels were destroyed, and wiring and instrument transformers damaged.

S-19868. Machine Shop. Six 185 K. W. air blast testing transformers were supplied from one fan. In the air duct, under these transformers, were about 50 wires, many of which were 500,000 C. M. rubber covered cable. These were mostly alternating current circuits of 55 volts to 2,300 volts, but the direct current shop line was also carried through the duct. A short circuit occurred in the duct, and at the same instant the circuit breaker on the shop line opened. This ignited the rubber covering on the cables and fire was communicated to the coils of four of the transformers. The circuits were made dead, the fan stopped, and the fire extinguished. Water was directed into the air duct through openings at the bases of the transformers. The insulation on the wires in the duct was completely destroyed and the lower part of the transformer coils was burned.

In replacing the burned cables, all wires were of the rubber covered type with a wrapping of asbestos paper between the rubber insulation and the braid, and the outer braid was treated with flameproof paint. Separate ducts were also provided for the cables, in order that the air duct should contain only short lengths of the primary and secondary connections of the transformers.

S-20350. Corset Factory. Two 3-inch conduits carrying 110 volts for lighting and power through lead covered cables were laid underground from the basement of one of the factory buildings to

dwellings belonging to the same owners. About twenty feet distant from the wall of the building the conduits were very nearly in contact with a city gas pipe, and there was a defective splice in the cable inside one of the conduits near this point. Apparently electrolytic action had eaten through both conduits, as well as the gas pipe, thus allowing gas to flow into the conduits where it became ignited from the defective splice. The flames made their way into the basement of the factory building between two racks of finished goods. One sprinkler operated and the fire was soon extinguished.

S-20373. Printing Establishment. Apparently a short circuit occurred at a point where electric wires passed under a sheet metal guard over the commutator end of a small motor used for driving a grinder in the finishing room. This motor was screwed to the wooden floor under the wooden bench supporting the grinder. The guard was installed, covering the entire commutator end and extending onto the motor frame for the purpose of protecting the commutator from metal chips flying from a routing machine nearby. The wires to the motor ran along the floor protected by conduit; the motor switch and rheostat were located on the side of the grinder bench; from the rheostat the wires ran through the side of the bench to the motor; at the motor they were taped together and passed between the metal guard and the motor frame to field and commutator. The only protection against the sharp edge of the guard was ordinary friction tape wound around the two wires. Examination of other motors similarly wired showed that the wires were held tightly between the sharp edge and the motor frame, and in some cases the tape protection and the insulation were badly abrased. This condition is easily explained by vibration from the heavy presses on the floor below. The grinder does not seem to have been used for several hours previous to the fire, and there is no evidence to show whether the motor was left running or whether the circuit was completely opened by the rheostat. Two sprinklers held the fire in check, operating for about 20 minutes. During this period, however, water had gone through the floors, and caused heavy damage to paper stock. Had blankets been available, their quick use would probably have greatly reduced the loss.

Matches.

S-19638. Jewelry Shop. A workman lost the tip of a lacquer sprayer near a small open pan of lacquer and lighted a match to find it. The lighted match immediately set fire to lacquer fumes and to the lacquer in the pan. One sprinkler opened and extinguished the fire.

S-19779. Metal Worker. A boy was sent to draw a pailful of black lacquer from a drum in a dark corner of the basement. He lit a match to watch the pail fill, and ran away, leaving the stream running, when the lacquer caught fire. The blazing liquid spread over the floor and caused a loss of more than $1,500.

S-20294. Laundry. Endeavoring to find a set screw which had fallen under a large steam-heated mangle, a foreman lighted a match, which set fire to the dry lint and fuzz under the mangle. The nearest chemical extinguisher proved a failure, as gritty dirt had been allowed to find lodgment in the nozzle. The promptitude of the forewoman in procuring another extinguisher and in assisting with fire pails was undoubtedly a factor in preventing a panic among the forty or more girls working on the floor.

Rubbish, Sweepings, Oily Rags.

S-19607. Paint Factory. Fire occurred during the night in a wooden barrel which had been left full of empty cans and rags, etc., though supposed to be emptied every night. The flames spread to some shelving above, whereon was a considerable quantity of empty cardboard boxes. Eight sprinklers opened and held the fire in check.

S-19991. Tenant Mercantile. The woman who waxed the floors each week had been in the habit of keeping her wiping cloths in a cardboard box on a shelf under the table where the fire occurred, and these rags apparently came in contact with a live steam coil near the table, spontaneous combustion being assisted by the heat from the coil. Owing to the susceptible nature of the paper stock, a loss of $8,300 (mainly water damage) was incurred. **It is of interest to note that this firm had taken elaborate precautions for the disposal of oily waste in the more hazardous section of their plant; but, as so often happens, the fire occurred where least expected.**

S-20067. Warehouse. Fire involving a loss of nearly $12,000 occurred in a box containing sweepings, excelsior, etc., which was placed by the side of two bales of excelsior. The fire evidently flashed up in the loose excelsior and ran up a post. A sprinkler head (dry pipe system) opened, and the air evidently blew the flame along the joist channel. In all, 18 sprinklers operated, and, owing to a recent change in the entrance way to the dry valves, some delay occurred in shutting off the water, thus permitting unnecessary water damage.

S-20074. Shoe Factory. Notwithstanding generally good management, wooden boxes were used for the reception of sweepings at this plant. Moreover the boxes were filled at night and not emptied until morning. One night fire occurred in one of the boxes, involving a loss exceeding $1,000 and causing the waste of several hours by the employees in getting water out of the building and raising stock, etc., from the flooded floors.

S-20324. Photo Supply Factory. Late on Saturday afternoon, after the plant had shut down, fire started in a wooden barrel used to hold misprints and damaged cards and paper. The barrel was located in a dark room in which sensitized post cards were printed;

and it stood near the press and against a frame partition, above which were several printing rolls on a rack. The fire began at the bottom of the barrel, burned through it, and crept up the partition, melting the printing rolls and communicating to the roof joists and the insulation of some electric wires. A metal ventilator in the roof probably carried off the heat, and delayed the opening of sprinklers. When the flames reached the ceiling, two sprinklers operated and extinguished the blaze. **Investigation showed that the wooden barrel contained a considerable amount of garbage and the ashes of rags. Nearby was a metal safety can with self-closing top. It was nearly empty, but had an accumulation of rags on its top.**

Celluloid.

H-11765. Machine Shop. Workmen in other parts of the factory heard an explosion at about 4 o'clock in the morning, and found the stock room on the first story of one of the buildings filled with smoke. A package containing two or three cotton bats on top of one of the stock racks was smouldering, as was also a wooden box which had contained about 1,000 small celluloid cards. The fire was promptly extinguished by the use of small hose, and it was found that all the celluloid cards had been burned. The stock rack was located directly under a line of electric lights, the cords of which were sufficiently long to allow the lamps to rest on top of the rack. They were all provided with large tin cone shades. At the time of the fire there seems to have been no electric current on this part of the building, and none of the employees had had occasion to visit the room affected; but it seems probable that one of the electric lights had at some time been placed on top of the box, and the celluloid heated, insufficiently to cause it to ignite, but sufficiently to render it unstable, with the result that, being partially decomposed, it later on ignited spontaneously.

S-20065. Celluloid Works. An employee is believed to have thrown a match or cigarette stub into a wooden box containing celluloid scrap. The employee in question was badly burned, and the fire swept over a low partition and against the ceiling, igniting paper boxes on shelves. Fumes and yellow smoke filled the building, in which there were employed 1,100 persons, mostly women and girls; but these were removed from the building without injury. The damage from fire was slight, but the water damage was heavy. Eighteen sprinklers opened and controlled the fire until the arrival of the city department. The loss could have been greatly reduced if the floors had been drained or scuppered and if the stocks of the various tenants in the building had been skidded.

Miscellaneous.

H-11749. Munition Factory. The origin of this fire was somewhat unusual. A steel goose-neck split at the gauge on an oil-driven press used to force copper rifling bands on shells. When the pipe

split, a stream of oil shot directly into the furnace in which the bands were heated. This furnace was oil-fired, and the oil immediately took fire and communicated to the wood backing of the switch board on the wall and to the roof girders overhead. The fire was promptly handled by the private brigade, and the loss was not heavy. A metal screen of suitable dimensions between the furnace and the press would probably have prevented the fire.

S-19615. Candy Factory. Gum drops were dried in a wooden drier, 10 feet by 6 feet. To provide for occasions when sufficient steam was not available, a small coal stove was installed in the drying enclosure. The workman responsible for the job carried the smoke pipe from the stove to a ventilator between the top of the dry room and the ceiling, which communicated with the outer air through the roof. The diameter of the smoke pipe was about two inches less than that of the ventilator, and on the day of the fire it is evident that sparks fell back through the space intervening between the two pipes and set fire to the top of the dry room. The fire spread under the ceiling, opening three sprinkler heads, and worked down into the dry room through the opening around the smoke pipe. The ventilator acted as a flue and carried much of the heat and smoke out through the roof, until its soldered joints melted on the floor above, and the escaping heat opened two more sprinklers. Had the dry room been sprinklered inside, the fire would probably have been extinguished very quickly, but, as it happened, the obstructions to the distribution of the water entailed a heavy water loss, as the stock was very susceptible and the water easily found its way through the floors.

S-19864. Machine Shop. Machine parts and tools were treated during the hardening process by immersion in a bath of cyanide chloride. This material was melted in an iron pot, six inches in diameter and twelve inches deep, set into a gas furnace and covered by a sheet iron hood. In the same room other parts were blued by means of saltpetre and manganese oxide, which materials were kept adjacent to the cyanide chloride. One of the workmen either through ignorance or carelessness emptied the saltpetre into the box of cyanide chloride. The foreman noticed this and ordered him to separate them, but as complete separation was impossible some of the saltpetre remained in the box. When the cyanide was next used, a violent explosion occurred in consequence of the oxidizing effect of the saltpetre. The metal hood covering the pot was blown apart, and three men were seriously injured. The pot, however, remained in place and the gas continued to burn. One sprinkler opened from the heat, but no fire ensued. If the various chemicals had been kept in separate locked boxes and these had only been opened one at a time as needed, the accident might have been averted.

S-19929. Cotton Waste Mill. This was the second of two fires. After the first fire a large quantity of damaged cotton was thrown outside the building, the pile reaching to a second story window.

This pile was found on fire by the watchman, and the building itself suffered considerable damage before the flames were extinguished. The operation of two sprinklers prevented fire from actually gaining entrance.

S-19981. Munition Factory. One of the solvent recovery buildings and a large amount of powder were burned at this plant as the result of ignition from static electricity generated by powder grains rubbing against each other as powder was emptied through a chute at the bottom of a bin. The contents of the bins are usually drenched with water before emptying, in order to increase the conductivity of the powder so that the static electricity may find its way to the metal linings which are grounded. On this occasion, however, the usual precaution was neglected and fire resulted. Although no explosion occurred, the burning of the powder was so rapid that the men in the building had their hair and eyebrows singed before they could escape through the exits, which were only a few feet distant.

S-20140. Tenant Manufacturing. Three pulleys forming a quarter turn drive were enclosed in a large belt enclosure which extended from floor to ceiling. The largest pulley (4 feet diameter) of iron ran very near to the end of planks which formed a cradle for another pulley. The cradle was held to a joist by lag screws. The pulley got out of alignment and rubbed the plank ends until it had worn about halfway through the lag screws, these screws becoming hot enough through friction to set fire to the plank and joist. Two pendant sprinklers opened in the belt box and extinguished the fire, but not before sufficient heat had been drawn out through two holes in the top of the belt box to cause three sprinklers outside to operate also.

S-20411. Foundry. The floor of this foundry was about three feet above the ground and consisted of a matched wood flooring about two inches thick on which was a layer of concrete. On Saturday afternoon a special casting weighing between 500 and 600 pounds was left on the floor to cool. Although there was usually plenty of sand on the floor, it is possible that there was not much under this particular casting, and the heat, penetrating the concrete, ignited the wooden flooring beneath. The fire was discovered by the watchman in the early hours of Sunday morning, although it had evidently been burning for some time, as it had gained considerable headway. On account of its inaccessible location it took three hours to extinguish, the burning through of the timbers in the meanwhile permitting a section of the floor to fall in. Following the fire it was decided to do away with the wooden under-flooring altogether.

S-20431. Automobile Factory. Electrically heated japan ovens were used in this plant, the heating units being at the bottom of the ovens, covered by a perforated metal plate. The work was introduced on metal trucks, having a drip pan to catch the drip, but this might occasionally fall outside the pan, as it is believed to have done

split, a stream of oil shot directly into the furnace in which the bands were heated. This furnace was oil-fired, and the oil immediately took fire and communicated to the wood backing of the switch board on the wall and to the roof girders overhead. The fire was promptly handled by the private brigade, and the loss was not heavy. A metal screen of suitable dimensions between the furnace and the press would probably have prevented the fire.

S-19615. Candy Factory. Gum drops were dried in a wooden drier, 10 feet by 6 feet. To provide for occasions when sufficient steam was not available, a small coal stove was installed in the drying enclosure. The workman responsible for the job carried the smoke pipe from the stove to a ventilator between the top of the dry room and the ceiling, which communicated with the outer air through the roof. The diameter of the smoke pipe was about two inches less than that of the ventilator, and on the day of the fire it is evident that sparks fell back through the space intervening between the two pipes and set fire to the top of the dry room. The fire spread under the ceiling, opening three sprinkler heads, and worked down into the dry room through the opening around the smoke pipe. The ventilator acted as a flue and carried much of the heat and smoke out through the roof, until its soldered joints melted on the floor above, and the escaping heat opened two more sprinklers. Had the dry room been sprinklered inside, the fire would probably have been extinguished very quickly, but, as it happened, the obstructions to the distribution of the water entailed a heavy water loss, as the stock was very susceptible and the water easily found its way through the floors.

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This pile was found on fire by the watchman, and the building itself suffered considerable damage before the flames were extinguished. The operation of two sprinklers prevented fire from actually gaining entrance.

S-19981. Munition Factory. One of the solvent recovery buildings and a large amount of powder were burned at this plant as the result of ignition from static electricity generated by powder grains rubbing against each other as powder was emptied through a chute at the bottom of a bin. The contents of the bins are usually drenched with water before emptying, in order to increase the conductivity of the powder so that the static electricity may find its way to the metal linings which are grounded. On this occasion, however, the usual precaution was neglected and fire resulted. Although no explosion occurred, the burning of the powder was so rapid that the men in the building had their hair and eyebrows singed before they could escape through the exits, which were only a few feet distant.

S-20140. Tenant Manufacturing. Three pulleys forming a quarter turn drive were enclosed in a large belt enclosure which extended from floor to ceiling. The largest pulley (4 feet diameter) of iron ran very near to the end of planks which formed a cradle for another pulley. The cradle was held to a joist by lag screws. The pulley got out of alignment and rubbed the plank ends until it had worn about halfway through the lag screws, these screws becoming hot enough through friction to set fire to the plank and joist. Two pendant sprinklers opened in the belt box and extinguished the fire, but not before sufficient heat had been drawn out through two holes in the top of the belt box to cause three sprinklers outside to operate also.

S-20411. Foundry. The floor of this foundry was about three feet above the ground and consisted of a matched wood flooring about two inches thick on which was a layer of concrete. On Saturday afternoon a special casting weighing between 500 and 600 pounds was left on the floor to cool. Although there was usually plenty of sand on the floor, it is possible that there was not much under this particular casting, and the heat, penetrating the concrete, ignited the wooden flooring beneath. The fire was discovered by the watchman in the early hours of Sunday m rning, although it had evidently been burning for some time, as it had gained considerable headway. On account of its inaccessible location it took three hours to extinguish, the burning through of the timbers in the meanwhile permitting a section of the floor to fall in. Following the fire it was decided to do away with the wooden under-flooring altogether.

S-20431. Automobile Factory. Electrically heated japan ovens were used in this plant, the heating units being at the bottom of the ovens, covered by a perforated metal plate. The work was introduced on metal trucks, having a drip pan to catch the drip, but this might occasionally fall outside the pan, as it is believed to have done

in this instance, causing ignition. The electric heating resistance reached a red heat, the oven being operated at about 425° F. Each oven was supplied with two 14-inch diameter vents through the roof and the dampers are said to have been open when the explosion occurred, this being a few minutes after the oven had been freshly charged with work. The oven doors were blown open, window glass in the room was broken and cracked, a partition at the cranaway was blown out and a partition at the finishing room was damaged, all by the force of the explosion. The heat caused twelve sprinklers to operate, and the paint on the drip boards nearby ignited. **It is apparent that, even with an electrically heated oven, work must be thoroughly dripped before being baked, and vents of thoroughly adequate size, equipped with dampers to open automatically, are recommended.**

H-11862. Miscellaneous Woodworker. A loss exceeding $8,600 resulted from spontaneous combustion in bituminous coal stored in a pile between and against the wooden walls of the west end of the main building and a 50 by 100 feet lumber shed. The fire extended into the lumber shed, and it was here that the principal damage was done.

H-11935. Metal Worker. Fuel oil was pumped to five annealing furnaces from a buried tank in the yard. The pump and blower were close to one of the furnaces. The oil is supplied to the furnaces by a 1¼-inch pipe running at the back of them, from which a ⅜-inch pipe passes under each furnace to burners at the front. The last-mentioned pipes were hung from the bottom of each furnace about twelve inches above the floor. There was a valve on each of these pipes close to its junction with the main feed pipe. The furnace doors in front were operated by a chain passing over pulleys above the furnaces and counterbalanced by weights hanging on chains at the back of the furnaces. From some cause, probably vibration, one of the weights fell and broke a ⅜-inch pipe at the tee connection, on the feed side of the small valve. Oil escaped and possibly ran under the furnace for some minutes before it was noticed. One of the furnacemen, observing that oil was not being fed to the furnace, looked below and saw oil escaping. Having ascertained that the break in the pipe was on the feed side of the valve, he was about to stop the pump, when the oil ignited, probably having been vaporized by the heat of the furnaces. As the oil had spread the pump and blower were enveloped in flames and consequently the valve at the pump could not be reached. The superintendent immediately went to the yard and shut off the oil at the buried tank. The fire was very skilfully fought by the furnacemen with hose, and the damage amounted only to $2,000 or thereabouts. A recurrence of the accident could be prevented by pinning the weights to the chains and by protecting the feed pipes.